A DISSERTATION ON

"AN EPIDEMIOLOGICAL AND ETIOLOGICAL STUDY ON ACUTE COMPARTMENT SYNDROME IN EXTREMITIES IN PATIENTS ADMITTED IN RGGGH"

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BONAFIDE CERTIFICATE

Certified that this dissertation is the bonafide work of Dr.D.DINESH on "**AN EPIDEMIOLOGICAL AND ETIOLOGICAL STUDY ON ACUTE COMPARTMENT SYNDROME IN EXTREMITIES IN PATIENTS ADMITTED IN RGGGH**" during his M.S. (General Surgery) course from May 2011 to April 2014 at the Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai - 600003.

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CONTENTS

LIST OF ABBRIVIATIONS

CS	:	Compartment Syndrome
CCS	:	Chronic Compartment Syndrome
PPS	:	Pain on Passive Stretch
EDL	:	Extensor Digitorum Longus
EHL	:	Extensor Hallucis Longus
FDL	:	Flexor Digitorum Longus
FHL	:	Flexor Hallucis Longus
ISS	:	Injury Severity Score
DVT	:	Deep Vein Thrombosis

ABSTRACT:

Compartment syndrome develops when the tissue pressure in a closed compartment is more than the perfusion pressure. It will reduction lead too reduction in blood supply to muscles and nerves. Late consequences include absent pulses, sensory disturbance, paresis. It is most commonly due to sequestration of fluid within the compartment or reduction in size of the compartment. Patient will have tightness or swelling of the involved limb. Paresthesia is the first sign to appear. Once paresis sets in, the disease is already advanced. Mostly tibial fracture will associated with this. Patient should be evaluated with X-Rays, arterial duplex, venous duplex. Compartment pressure is measured by various techniques. But none of them is accurate. So high index of suspicion for compartment syndrome is important. Management requires emergent fasciotomy followed by treatment of etiology. But fasciotomy is contraindicated in advanced dieases for fear of infection. Myoglobinuria if present it should be addressed simultaneously. In our study, it is the trauma which is most common etiology. Lower limb involvement is outnumbered upperlimb. In trauma , both bone fracture leg is most common etiology. A simple fasciotomy can save limb and prevent morbidity.

INTRODUCTION

Compartment Syndrome develops when pressure of tissue in a closed fascio osseus compartment more than the perfusion pressure. It will lead to reduction in blood supply to muscles and nerve. It is mainly due to trauma, the most common etiology will be fracture.

Acute Compartment Syndrome is a cyclical event when the pressure within the tissue is more than the pressure in the blood vessel. It consequently leads to reduction in blood flow. It leads to poor oxygenation of tissues and there will be no washing out of products of metabolites. It prominently affects the nerve first and leads onto sensory disturbances.

Late consequence of this include arterial pulses will be absent, numbness particularly fine touch and two point discrimination, paresis of the involved muscle. All these are the consequence of reduced blood flow. If this is not treated within a particular interval of time, necrosis of tissue within the compartment occurs and later it will under go fibrosis which is called ischemic contracture.

There are two types of compartment syndrome -- acute and chronic. Compartment syndrome can also be caused by crush syndrome and rhabdomyolysis.

Chronic compartment syndrome is caused by exercise or work. Main symptom will be chronic pain. It will recur again when the patient returns to that particular activity. Anterior compartment of the lower leg will be the most commonly affected part.

The prevalence of CCS depends on the population group studied and the etiology. It is noted that 14% of patients with chronic leg pain will be suffering CCS.

Any part of the body will be affected by compartment syndrome. When patient complains of chronic leg pain, clinician should rule out CCS.

The treatment for compartment syndrome is purely surgical i.e. Decompression of the involved fascio osseus compartment, subsequently followed by management of vascular injury and fracture.

AIM AND OBJECTIVE

- To study the incidence of compartment syndrome, with respect to
  - Age
  - Limb involvement
  - Region of limb involved
  - Etiology
  - Clinical symptoms an signs
- To identify the high risk group
- To study the various etiological factors for compartment syndrome

REVIEW OF LITERATURE

Richard Von Volkmann was the first person to describe about the clinical features of neglected compartment syndrome. In his article which was published in 19th century, he noted about contracture of the forearm following fracture of supracondylar region of the humerus. In this he noted that sensory disturbance was the prominent feature.

Usually compartment syndrome develops as result of result of fracture involving the long bone. It can also happen with other possible aetiologies also. After 50 years of the article, another person studied the contracture in hind legs of canine after inducing obstruction in hind leg venous system.

In early part of 20th century, Wilson described about compartment syndrome due to exertion in an athlete. In the middle of 20th century Mavor described about the CCS. Following there are numerous cases has been reported and there are numerous articles described about the compartment syndrome.

Bywaters and his colleagues explained about compartment syndrome caused by crush injury in those who affected in London Blitz. They are the one who explained about the clinical signs, symptoms, and mechanism of developing compartment syndrome

During the late 1970's there articles which explained about the compartment pressure measurement. One of such article published by Matsen and his colleagues is followed now-a-days. Owen and his colleagues published a literature which explains about the compartment pressure measurement by Wick technique.

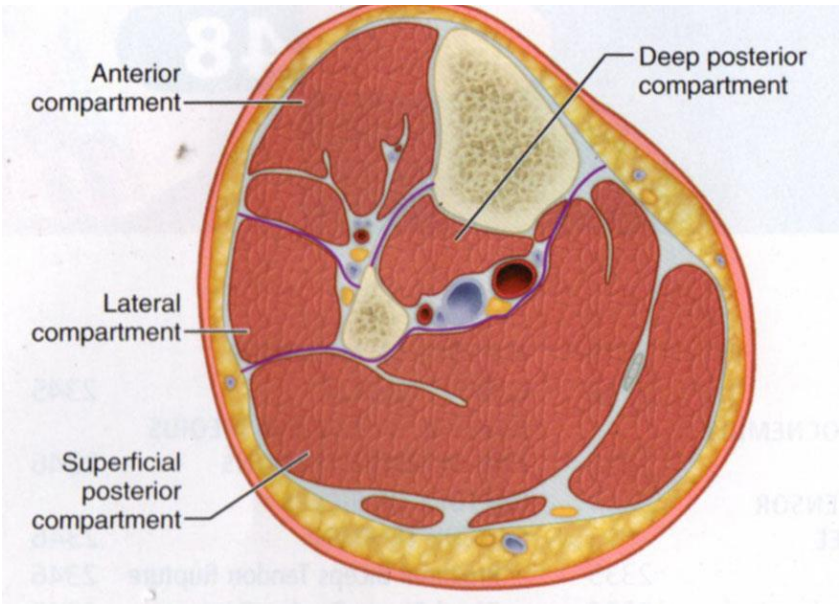
ANATOMY

Before going to deatailed features of signs and symptoms of compartment syndrome we should know the anatomy of lower limb and upper limb.

LEG

In the leg there are four fascio osseous compartment, they are,

- ❖ “Anterior Compartment”
- ❖ “Lateral Compartment”
- ❖ “Superficial Posterior Compartment”
- ❖ “Deep Posterior Compartment”



ANTERIOR COMPARTMENT

Muslce include

- “Antrior Tibialis Muscle”
- “EDL” Muscle
- “EHL” Muscle
- “Peroneus tertius” muscle

Boarders are

- “Tibial Bone”
- “Fibular Bone”
- “Interosseus membrane connecting the tibia and fibula”
- “Anterior intermuscular septum”

Anterior tibial artery and vein belongs to this compartment

LATERAL COMPARTMENT

Muscles

- “Peronius longus” muscle
- “Peronius brevis” muscle

“Common peroneal nerve and its branches” belongs to this compartment.

Lateral compartment borders are

- “Anterior intermuscular septum”.
- “Fibular bone”
- “Posterior Intermuscular septum”
- “Deep fascia”.

SUPERFICIAL POSTERIOR COMPARTMENT

Muscle

- “Gastronemius – Medial & Lateral head”
- “Soleus muscle”
- “Plantaris muscle”

DEEP POSTERIOR COMPARTMENT

Muscle

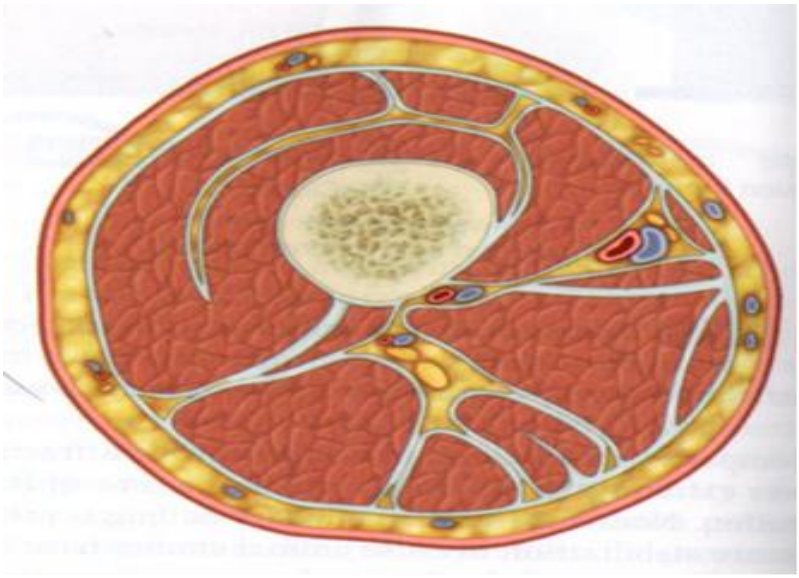
- “FDL Muscle”
- “FHL Muscle”
- “Popliteus Muscle”
- “Posterior Tibialis Muscle”

“Posterior tibial artery and vein” belongs to this compartment. “Tibial nerve” belongs to this compartment.

Boarder are as follows

- “Tibial Bone”
- “Fibular Bone”
- “Deep Transverse Fascia”
- “Interosseous membrane”

Anatomy of thigh



It is divided into 3 compartment by inter muscular septations.

- “Anterior Compartment”
- “Posterior Compartment”
- “Medial Compartment”

ANTERIOR COMPARTMENT

Muscles

- "Quadriceps muscle"
- "Sartorius muscle"

Nerve of the compaertment are

- "Femoral nerve"
- "Saphenous nerve"

Vessels are this compartment are

- "Femoral Artery" and
- "Femoral Vein"

POSTERIOR COMPARTMENT

Muscles

- "Biceps femoris"
- "Semi membranous"
- "Semi tendinosus"

Artery of this compartment is

- "Profunda Femoris artery"

Nerve of this compartment is

- "Sciatic nerve"

MEDIAL COMPARTMENT

- "Gracilis"
- "Adductor longus"
- "Adductor magnus"
- "Adductor brevis"

Artery of this compartment is

- "Profunda femoris artery"
- "Obturator artery"
- "Obturator vein"

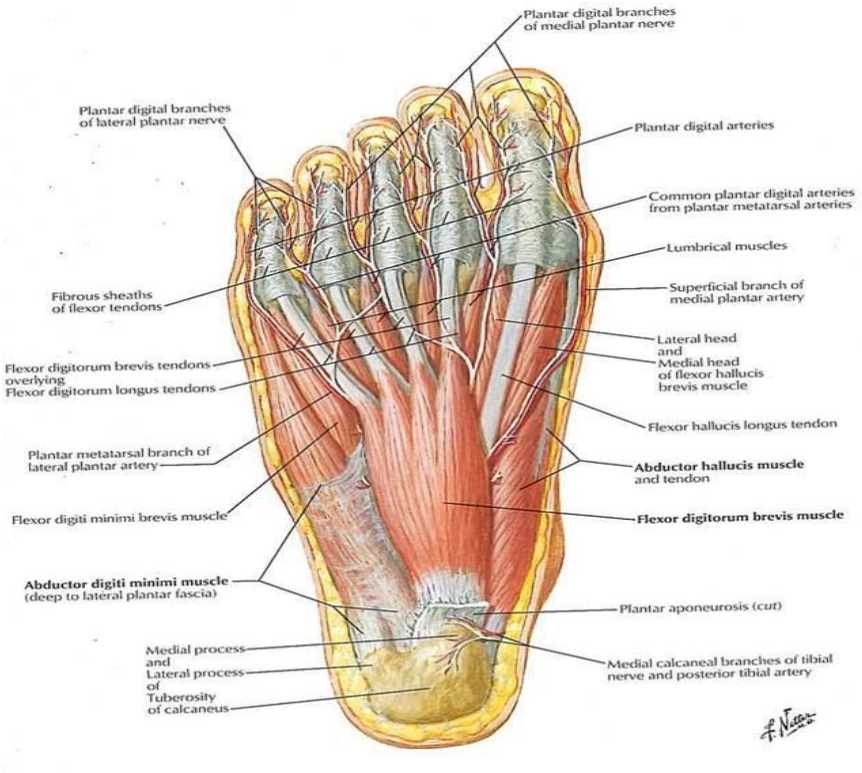
Nerve of this compartment is

- "Obturator nerve"

FOOT

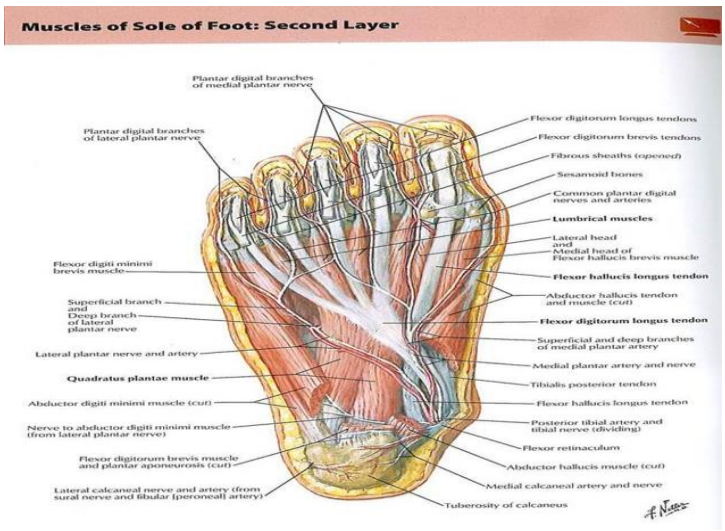
1st Layer

- "Abductor Hallucis"
- "Flexor digitorum brevis"
- "Abductor digitii minimi"



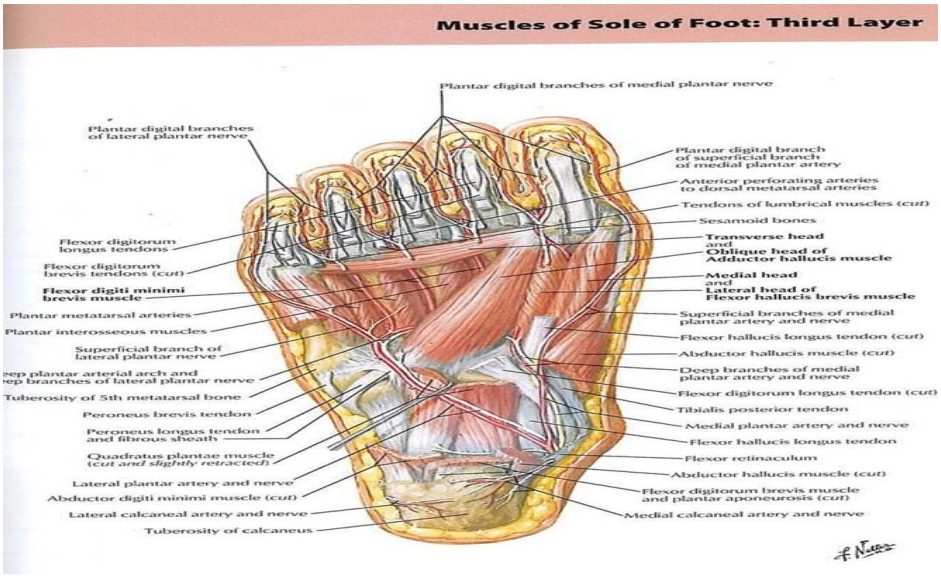
2nd Layer

- "Quadratus plantae"
- "Lumbricals"
- 'Tendons of FDL & FHL



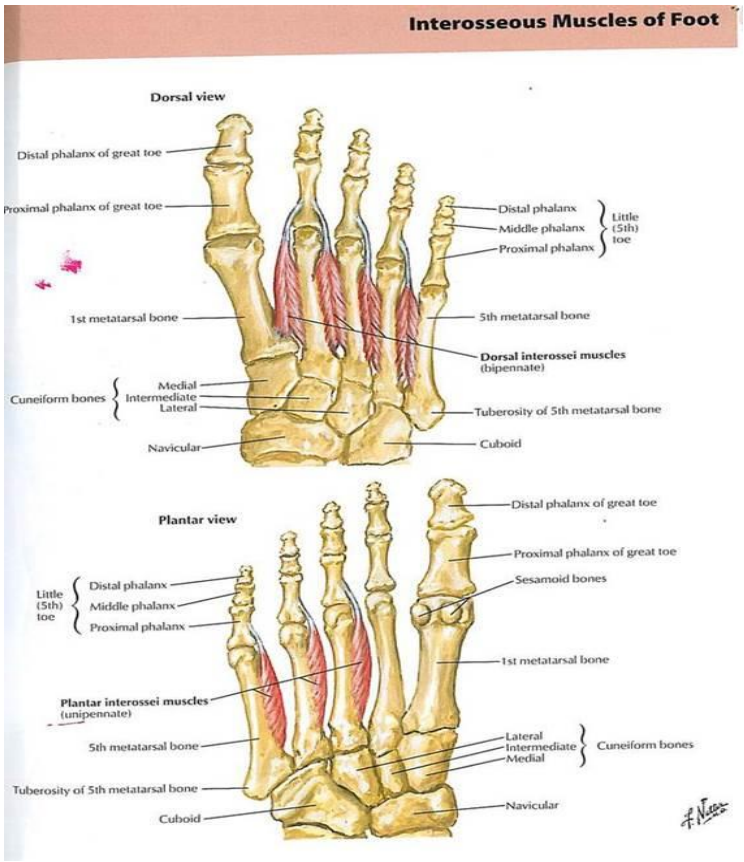
3rd Layer

- "Flexor hallucis brevis"
- "Adductor hallicus"
- "Flexor digiti minimii brevis"



4th Layer

- "Dorsal and plantor interossei"



FOREARM

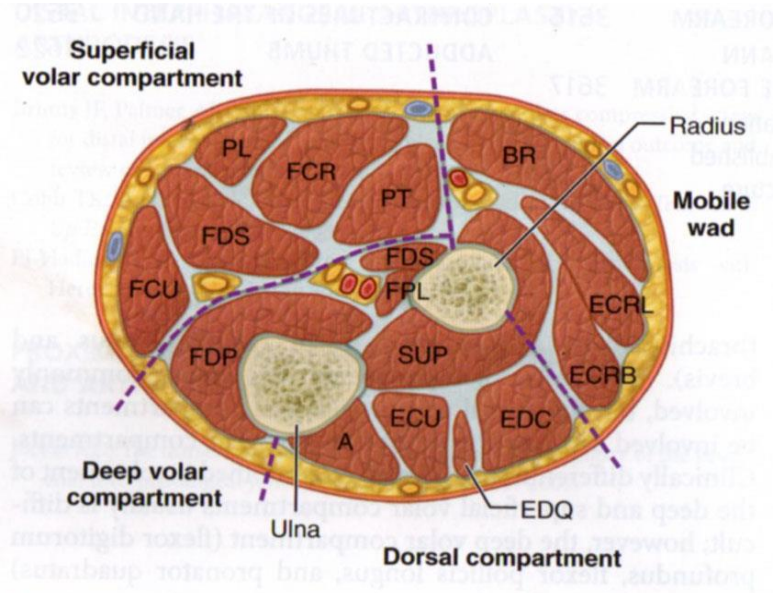
- There are four compartment in the forearm which are inter connected.
- "Superficial flexor compartment"
- "Deep flexor compartment"
- "Extensor Compartment"
- "Mobile wad of Henry."

DEEP VOLAR

"FDP (Flexor Digitorum Profundus Muscle)"

“FPL (Flexor Polilicis Longus muscle)”

“PQ (Profunda Quadratus)”



“MOBILE WAD OF HENRY”

“Brachioradialis”

“ECRB (Extensor Carpi Radialis Brevis)”

“ECRL (Extensor Carpi Radialis Longus)”

“SUPERFICIAL VOLAR”

“Pronator teres”

“FCR (Flexor Carpi Radialis Longus Muscle)”

“Palmaris Longus”

“FCU (Flexor Carpi Ulnaris Muscle)”

“FDS (Flexor Digitorum Profunda Muslce)”

“DORSAL COMPARTMENT”

Superficial Layer

“ED (Extenor Digitorum Muscle)”

“EDM (Extensor Digiti Minimi Muscle)”

“ECU (Extensor Carpii Ulnaris Muscle)”

“OUT CROPPPING MUSCLES OF DEEP LAYER”

“APL (Abductor Pollicus Longus Muscle)”

“EPL (Extensor Pollicis Longus Muscle)”

“EPB (Extensor Pollicis Brevis Muscle)”

“Supinator”

“Extensor Indicies”

Volar compartment is frequently affected compartment in the forearm. But Compartment Syndrome infrequently affects dorsal and Mobile Wad of Henry compartments. But in clinical practice it is difficult to pinpoint which compartment is affected and also in forearm more than one compartment is usually affected.

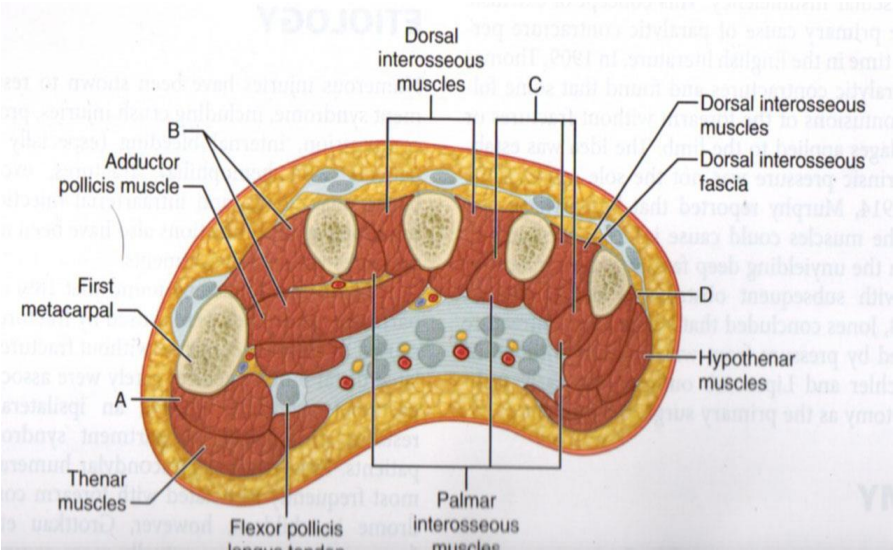
WRIST

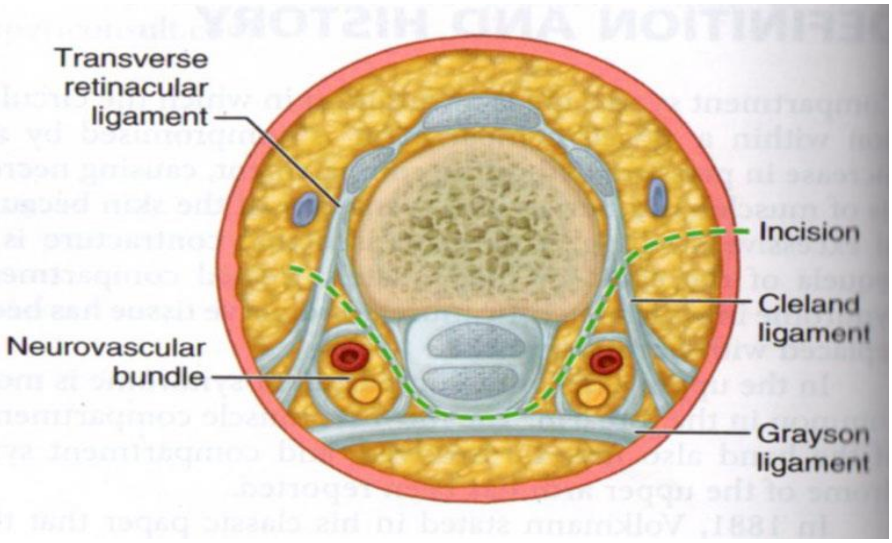
Most of the muscle tendons with in the wrist are tightly packed into compartment. In the volar aspect through the carpel tunnel, tendons of Flexor Digitorum Profundus muscle, Flexor Digitorum superficialis and Flexor Pollicis Longus passes

-“FCR”

-“FCU”

-“PL” All these three are enclosed with in a separate compartment.





IN DORSUM

Extensor tendons from the forearm pass to finger through extensor retinaculam in the dorsal aspect of wrist.

1st Compartment contains “Aductor policis longus, Extensor policis Brevis”.

2nd compartment contains “Extensor Carpi Radialis Longus and Brevis”

3rd compartment contains “Extensor Pollicis Longus”

4th compartment contains “Extensor Digitorum, Extensor Indicis

5th compartment contais “Extensor Digiti Minimii”

6th compartment contains “Extensor Carpi Ulnaris”

HAND

Int hand, there are 10 compartment.

- There are four “dorsal interrossei” and each dorsal interrossei consider as single compartment. Hence there are four compartments.
- There are three “palmar interrossei” which are considered as single compartments. Hence there are three compartments.
- 8th compartment contains “adductor pollicis”
- 9th compartment contains “thenar muscles”
- 10th compartment contains “hypothenar muscles”

EPIDEMIOLOGY

The incidence and prevalence of compartment syndrome varies according to the region, availability of tertiary care centres and knowledge of the medical professionals. The various studies show that anterior compartment of the lower leg is the most commonly involved in compartment syndrome. It is also confirmed that fracture of the tibia is the most commonly associated one. In a randomised control study conducted by McQueen and his colleagues in 175 patients who were diagnosed to be compartment syndrome, tibial fracture is the most common etiology. Men are supposed to be most commonly involved. In another study conducted by same person and arrived at conclusion that in patients presenting with tibial diaphyseal fracture there should be continuous monitoring of intra compartmental pressure is mandatory.

Inciting event also influence the incidence and prevalence of compartment syndrome. In a retrospective study conducted by DeLillie concluded that compartment syndrome is caused by communited fracture of tibia 7% compared with only 1% with closed fracture of tibia. But in most cases this clinical syndrome is

usually not detected by many surgeons. In a study conducted by Feliciamo found that incidence of this clinical Syndrome is more when the vessel injury is present.

ETIOLOGY

Any inciting event which increases pressure in a closed compartment leads to this clinical entity. Most commonly due to sequestration of fluid within the compartment or reduction in the size of the compartment.

Increased fluid sequestration due to

- “Extensive usage of muscle”
- “Day to day activities”
- “Snake bite”
- “Reduced osmolarity of serum”
- “Exsanguination into the compartment”
- “Revascularisation”
- “Substance abuse”
- “Ethanol abuse”
- “Rhabdomyolysis”

- “internal degloving”
- “Myositis due to viral etiology”
- “Deep venous thrombosis”
- “Hypertrophy of muscle”
- “Mooren-Baker cyst which is ruptured”

Upper extremity compartment syndrome is most commonly seen in patients with fracture involving the supra condylar region of the humerus, radial or ulnar diaphyseal fracture, fracture involving the surgical neck of humerus and colle's fracture.

In the hand, compartment syndrome is most commonly due to compressive injuries. It is associated with fracture. It results in fibrosis of intrinsic muscles similar to that seen in forearm.

There are literature which shows evidence of CCS in first dorsal interosseus muscle due to those involving in long two wheeler rides.

But in case of thigh it is the trauma and injury to vessel which causes this clinical phenomenon. Considering trauma may or may not involve fracture of the femur. Others include

- “Idiopathic”
- “Polytrauma”
- “Acute ischemia”
- “Electrical burns”
- “Compression injury”
- “Penetrating wounds”
- “Muscle rupture”
- “Muscle contusion”

Factors associated with high morbidity include

- “Increased ISS”
- “Femur fracture”
- “Prolonged time for surgical intervention”
- “Age > 30 years”

In case of leg, it is mostly due to

- “Both bone fracture”
- “Muscle injury”

It also depends on

-Mode of injury (most commonly due to penetrating wounds following RTA)

-Other risk factors for developing compartmental syndrome include

- "Age of the patient less than 55"
- "Male patients"
- "Heparin or warfarin usage."

There are literatures showing compartment syndrome in neonate a due to extremity strangulation by umbilical cord.78

Intra compartmental pressures varies depending on the various positions of parts of the body during sleep

- "50mm of Hg when the forearm is below the head"
- "180 mm of Hg when the forearm is below the rib age"
- "70 mm of Hg when leg was folded"

"Iatrogenic causes"

- "Military trousers"

- “Application of plaster of Paris”
- “Tight dressings”
- “Surgical positions eg : lithotomy”
- “Inadvertent intra vascular infections”
- “Hypertonic saline overload”
- “Attempting intravenous cannulations in those individuals on heparin or warfarin medications”
- “Fluid infusion into joints”

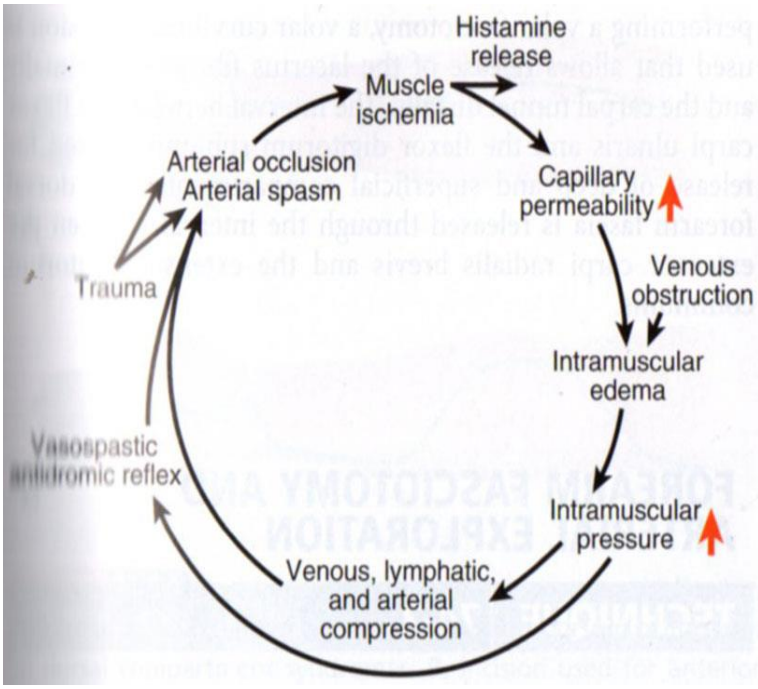
Compartment syndrome may also develop in the orthopedic post operative patients especially those who underwent procedure for fracture fixation.

This is attributed to

- “Any hematoma”
- “Tissue edema”
- “Tight closing of fascia”

PATHOPHYSIOLOGY

Any inciting event which increases pressure in a closed compartment lead to this clinical entity. It is most commonly due to sequestration of fluid within the compartment or reduction in the size of the compartment. Cyclical event leads to this syndrome is given below



Any trauma which causes arterial occlusion or spasm leads to muscle ischemia. It causes histamine release from the myocytes and also causes increased capillary pressure. It lead on to muscle oedema and which causes pressure within the fascio-osseous to be increased. If this pressure exceeds pressure in the small vessels, perfusion to muscles and nerve will be compromised. Again this

will lead onto muscle ischemia. Again the viscious cycle continuous.

If this is going on, at one point necrosis of the muscle occurs and at later date fibrosis of the muscle ensues in which clinically call it as Volkmann's ischemic contracture.

Clinically two types of compartment syndrome has been noted.

- Acute
- Chronic Usually the first one is associated with trauma and second one is associated with chronic exertion.

Blood supply to a particular tissue depends on the perfusion pressure of the capillaries and pressure in interstitial space.

Blood flow to a tissue depends on difference of pressure in the venous system and the pressure in the arterial system divided by resistance of the vessel wall.

Where BF is blood flow, PA is pressure in artery, PV is pressure in vein and R is resistance in peripheral vessel.

Normal metabolism in muscle cells requires at least 6-8 mmHg oxygen tension usually got it from 26mmHg perfusion pressure of the capillaries and 5mmHg pressure in interstitial space

When fluid is sequestrated into closed fascio-osseous compartment, the pressure within the compartment rises, which causes arterial occlusion and leads to muscle ischemia. Ischaemia causes instability of the cell membrane and release osmotically active substance into the interstitial space. 1 mOsm is expected to increase a pressure of 20 mmHg. Hence presence of minimal osmotically active substance in a compartment sequestrates fluid.

Because of this, pressure in the interstitial space increases. Once this pressure exceeds pressure in the small vessels, perfusion to muscles and nerve will be compromised. Again this will lead onto muscle ischemia. Again the cycle continues.

In the initial phases pressure difference will be overcome by auto regulation. Once the pressure exceeds the critical level, auto regulation will fail.

The transmural pressure is determined by the sympathetic tone and pressure in the interstitial space. There is critical

transmural pressure at which blood flow to the tissue stops. But there are confusion exists regarding the critical transmural pressure.

The critical compartment pressure at which decompression of the fascio osseus compartment is 30mm of Hg. If compartment syndrome is neglected muscles and neurons will undergo necrosis. During the process of healing, muscle tissues are replaced by fibrous tissues which lead onto contracture of the limb. Clinical signs and symptoms are mainly due to inability to meet the metabolic demands of the tissues.

Amount of pressure a limb can withstand depends upon

- “Tissue type.”
- “Blood pressure of the particular limb”.
- “Status of the blood vessels i.e. Presence of any Athero sclerotic pathology”.

Upon lysis of cell membranes not only the osmotically active substances released but also myoglobin also enters into the systemic circulation. It is the main reason for acute renal failure in patients with compartment syndrome. Mortality in compartment syndrome is mainly due to acute renal failure and septicemia.

Following vascular trauma once the blood flow to the limb is established after a long standing occlusion, it is the reperfusion which causes the acute compartment syndrome. This mainly because of accumulated toxic metabolites enter into systemic circulation which is responsible in this scenario.

PRESENTATION

HISTORY

Usually patients will complaint of tightness of extremities or limb swelling

1) Age of the patient is important, because lesser the age prognosis will be better.

2) Enquire about the nature of the work, because soldiers and athletes are at high risk of developing chronic exertional compartment syndrome.

3) Mode of injury -- blunt injury associated with internal degloving injury or penetrating injury. Because we can predict the vessel injury in which case compartment syndrome develops early. This is more common in penetrating injury.

4) Details of pain should be asked which include -- nature of pain, progression of pain, any relation to the movement of limb because pain on passive stretch is an early clinical sign which can predict compartment syndrome.

5) Patient should be enquired about any sensory disturbances, particularly numbness because, in compartment syndrome, if blood supply compromises, it is the sensory nerves which affected first.

6) History of any medications -- those patients on heparin/ warfarin possess high risk for development of compartment syndrome.

7) When considering hand there are subtle signs and symptoms of compartment syndrome. So there should be high index of suspicion.

PHYSICAL EXAMINATION

- Look for hemodynamic status of the patient. Example -- pulse, blood pressure.

- Hydration status of the patients -- because patients with long bone fracture may become hypovolemic and chances of developing hypovolemic shock are high.

- Look for any deformity of the limb, abnormal mobility crepitus to rule out any fracture

- Site of fracture or dislocation of joints.

- There are region where there is possibility of vessel injury depending on the site of fracture. Because these patients are high risk for developing compartment syndrome

- Look for colour, local temperature of the limb

- Look for peripheral pulses

- Examine for any development of pain after passive stretching of muscles. This is the earliest sign.

- Sensory examination -- two point discrimination, vibration sense using 256 hz tuning fork to be tested. These sensory disturbances occur in the early phase of compartment syndrome

- Motor examination - Paresis or Paralysis of the muscle is the late feature of compartment syndrome. If this is present, tissue insult is usually irreversible tissue. Tissue/ muscle function cannot be reversed back even after surgical decompression.

Systemic manifestations of compartment syndrome

Toxic appearance	
Fever	Weakness
Constitutional symptoms	Tachycardia
Shock	Tachypnea
Multiorgan system failure	Decreased urinary output
Mental status changes	Death

D/D

- "Cellulitis"
- "Snake bite"
- "DVT"
- "Necrotising fasciitis"
- "Gas gangrene"

- ❖ “Peripheral vascular ischemia”
- ❖ “Rhabdomyolysis”
- ❖ “Stress fracture”

APPROACH TO PATIENT WITH COMPARTMENT SYNDROME

1) Complete Blood Count - It is useful investigation to know the volume of blood loss. It can predict the need for any blood or blood component transfusion. Anemia reduces oxygen carrying capacity.

2) Serum creatinine - It is the more sensitive indicator of renal function which is usually hampered in cases of -- myoglobinuria, hyperuricemia due to purine metabolites

3) Blood urea - also indicates renal function but may vary with the hydration status and muscle mass of the patient

4) Serum electrolytes - particularly potassium is important because it is elevated in ARF due to compartment syndrome or myoglobinuria. Hyper kalmia scan lead to arrhythmia and sudden death.

5) Arterial blood gas analysis - particularly useful in ARF. It will guide in the correction of pH and also useful in the correction of any anion gap.

6) Urine routine

7) Serum creatine phosphokinase - it is elevated in cases of rhabdomyolysis which shows patient is developing compartment syndrome.

8) Urine myoglobin - again elevated in case of rhabdomyolysis where compartment syndrome is going on in this patient

9) Coagulation profile

PT/INR, aPTT, BT, CT.

10) X rays -- to look for site of fracture, nature of fracture, peri osteitis in case of stress fracture which is useful in intervention or any procedures.

11) MRI - this is particularly useful when there is a high index of suspicion of internal degloving injury.

12) Arterial duplex - it can delineate whether the flow is triphasic or biphasic or monophasic, site of obstruction, hemodynamic nature of obstruction.

13) Venous duplex - to rule out DVT.

In a patient with typical symptoms and signs, there is no need for laboratory investigations because it is usually normal and are not useful to diagnose or rule out compartment syndrome.

14) Conventional or CT Angiogram - it is of particular value in case of adductor canal compression syndrome and popliteal artery entrapment syndrome.

15) Compartment pressure - there are plenty of ways to measure the intra compartmental pressure. A transducer which is connected to a catheter is inserted into compartment. It is the ideal method for measuring the intracompartmental pressure.

For accurate measurements, compartment pressure should be measured at rest, during and after exercises.

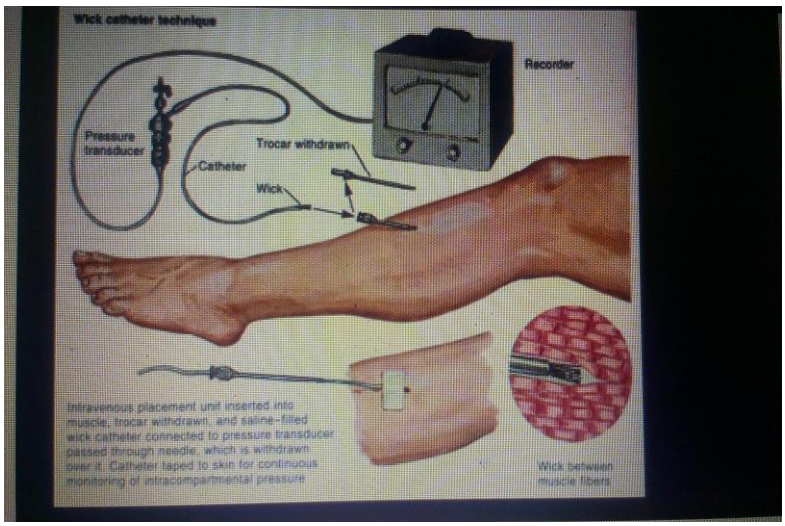
For diagnosing compartment syndrome, the threshold pressure is 30 mm of Hg. Some of the authors cited that it is good to relate this pressure to diastolic pressure. It measurement using

- Injection technique”
- “Wick technique”
- “Doppler USG using laser”
- “Contrast enhancing MRI (contrast used here is methoxy iso butyl isonitrite)”
- “Nuclear scanning 99m Tc, sestambi, xenon, thallous chloride”

OTHER NEWER MODALITIES

- “Electronic transducer -- tipped catheter system”
- “Ultrasonic device”
- “Pulsed phase localised loop USG”

WICK CATHETER TECHNIQUE



Components are

1) Wick catheter

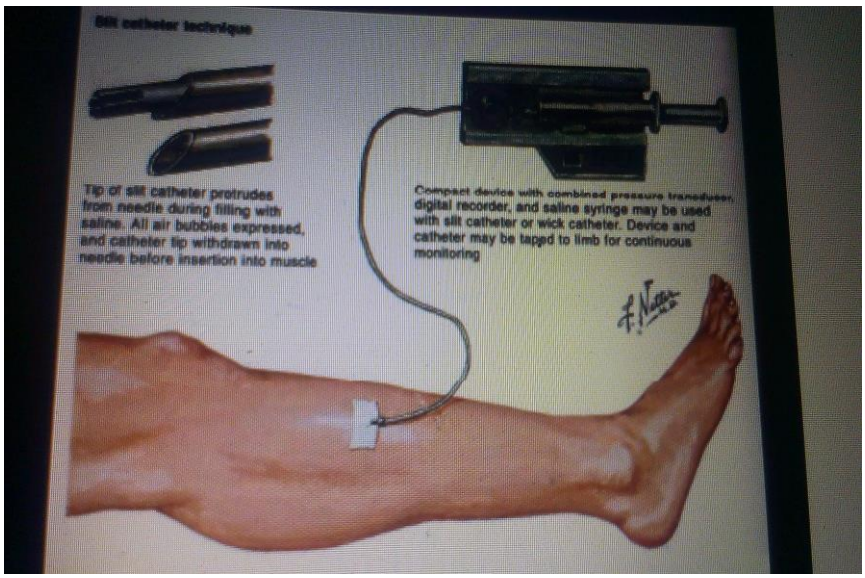
2) Trocar needle

3) Pressure transducer

4) Pressure recorder

Here the pressure transducer connected to pressure recorder. Another end is connected to catheter which is again connected to wick. Trocar with needle is inserted into compartment where pressure is to be measured and needle is withdrawn. Saline filled catheter along with wick is inserted into trocar and guide into compartment. Catheter should be fixed to skin.

SLIT TECHNIQUE

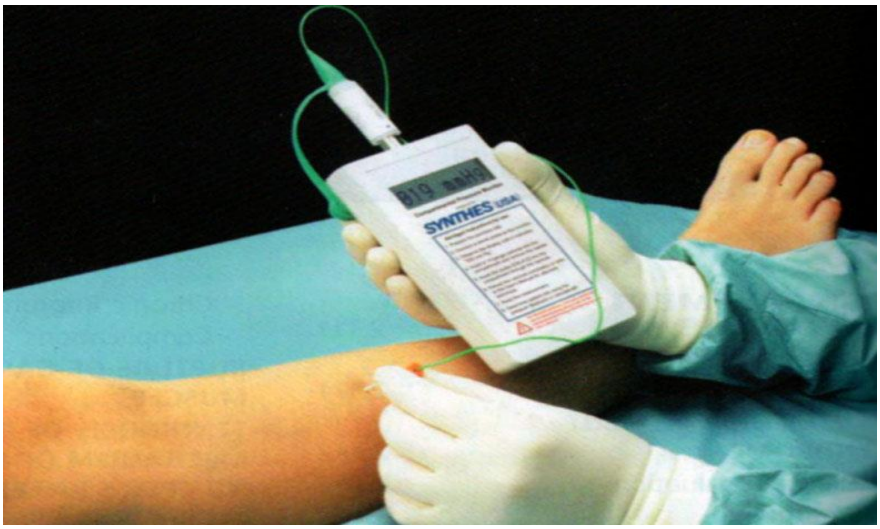


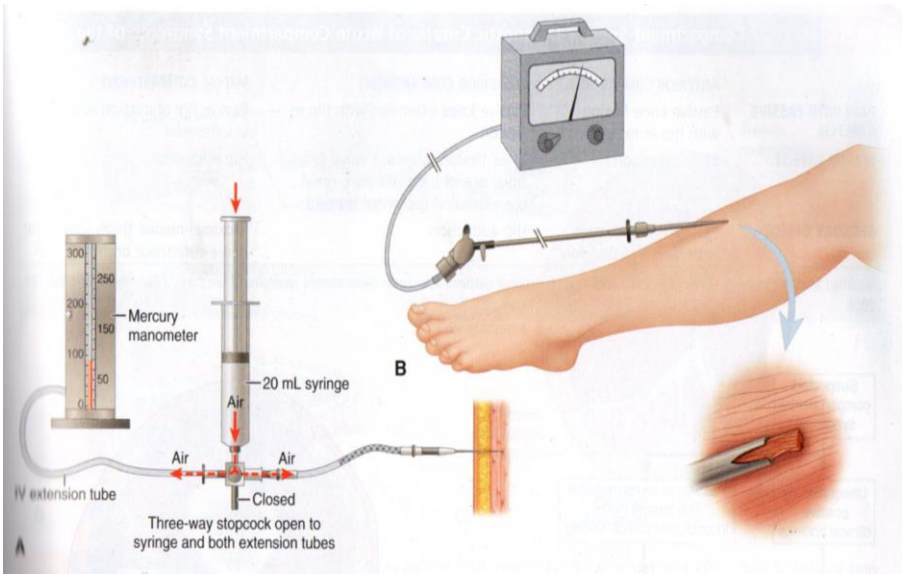
Tip of slit catheter protrudes from needle during saline filling. Air bubbles should be let out. Catheter tip should be withdrawn into needle before insertion into muscle.

It is a compact device which contain pressure transducer, digital recorder, and saline filled syringe all in one system.

If these devices are not available it is easy to measure the compartment pressure at bedside provided following are available :

- “20 ml syringe -- 1 in no”.
- “3 way adapter”
- “18G IV catheter”
- “90 cm tube -- 2 in no”.
- “18G needles -- 2 in no”.
- “1 bottle NS”
- “Elastoplaster”


SYNTHES


300
250
200
150
100
50
0
Mercury manometer
20 mL syringe
Air
Air
Air
IV extension tube
Closed
Three-way stopcock open to syringe and both extension tubes
A
B

PROCEDURE TO MEASURE THE INTRA COMPARTMENTAL PRESSURE

- Patient should be in supine position
- Parts should be painted and draped
- One end of long tube should be connected to 18G needle
- Another end of it should be connected to one end of stop cock
- 20 ml syringe is connected to vertical limb of stop cock.
- Another long tube should be connected to sphygmomanometer
- Another end of it should be connected to another end of stop cock.
- Syringe should be inserted into the saline bottle and small amount of saline withdrawn into the tube.
- Now needle is withdrawn and inserted into the compartment whose pressure is to be measured
- Gradually increase the system pressure by pushing the syringe plunger. When there is increased pressure, mercury will move. When pressure is more than the intracompartmental pressure, saline will move into the

compartment and the column of meniscus will move. Reading should be noted which shows ICP.

There are articles which shows how to measure the forearm and hand compartment pressure.

APPROACH TO THE PATIENT

Management

Successful management of Compartment Syndrome includes

- Early diagnosis
- Surgical decompression
- Wound care
- Antimicrobial therapy
- Renal support
- Intensive supportive care
- Hyperbaric oxygen

Key factors in the management of Compartment Syndrome is early identification of Compartment Syndrome. After confirming the diagnosis, it is important to do fasciotomy.

The affected limb should be placed at the level of heart. Because lib elevation, causes reduction in blood flow to limb which again jeopardizes the limb.

For fracture of the tibia, the involved limb should be immobilized in a Thomas Splint and plantar flexion of the ankle joint should be advised. It should be done because the deep posterior compartment pressure will be reduced.

Removal of bandages and casts should be done. There are studies shows

- Releasing the cast on one side will decrease the pressure by 30%.
- On both side, if released it will decrease the pressure by another 35%.
- If the cast is removed completely additional 15% will be reduced. On the whole, if complete removal of cast, 85% reduction in the compartment pressure occurs.
    - Correct hypovolumia, by infusion of normal saline, blood transfusion, platelets, FFP transfusion.
    - Look for colour of the urine and urine output.

- Maintain I/O.Chart.
- Administer proper antibiotics.
- In case of snake bite, administer ANTI SNAKE VENOM after checking for hypersensitivity to it.

The important aspect in the management of Acute Compartment Sundrome is the management of Rhabdomyolysis.

1) Hemodynamic status of the patient should be improved using
   a. Intravenous fluids
   b. Blood transfusion either in the form of whole blood (or) packed cells.
2) Forced alkaline diuresis should be done. This done by administrating frusemide and sodium bicarbonate. This is because alkalinasation of urine increases the solubilisation of Heamoglobin and Myoglobin.
3) Monitor the urine output. If the urine output is <0.5ml/kg/hr mannitol should be administered.
4) Monitor, pulse, blood pressure, hydration status of the patient.

5) Monitor

a. ABG

b. K+, CO3–, Na+, Cl–

c. Serum Osmolarity

6) Still, there is no urine output advice to get Nephrologist opinion regarding HD.

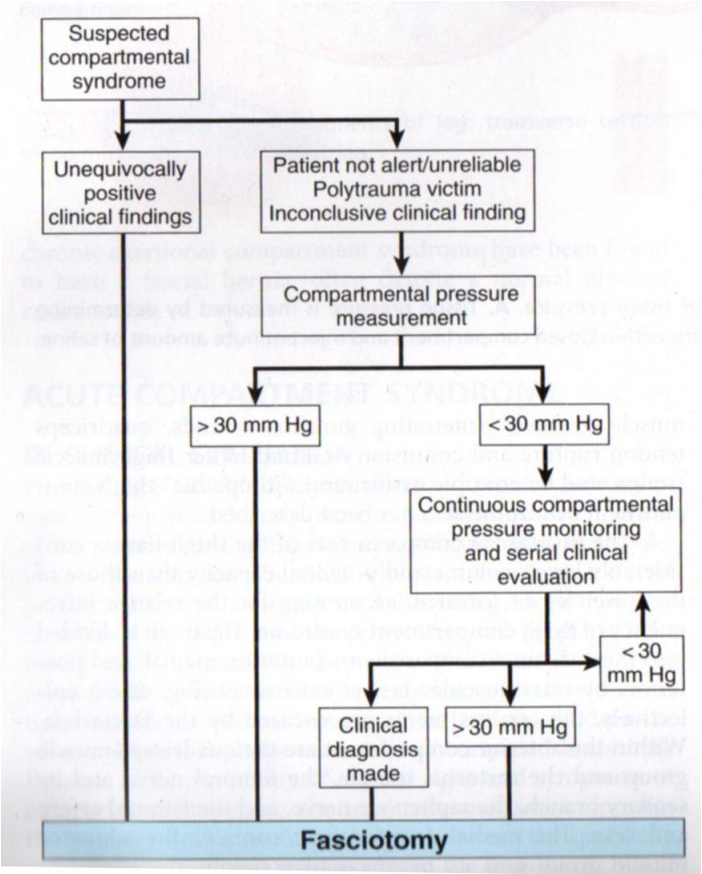
Management of Rhabdomyolysis is important because, If acute compartment syndrome was diagnosed at a latest stage, products of tissue necrosis i.e. product of muscle necrosis myoglobin will enter into systemic ccirculation myoglobin is nephrotoxic. It causes acute tubular necrosis which lead on to acute renal failure.

INDICATIONS FOR FASCIOTOMY

The treatment of choice for elevated intra compartmental pressure is fasciotomy. If there is any fracture which causes Compartment Syndrome, it should be reduced. If there is any associated vascular injury, it should be addressed simultaneously.

When there is high suspicion for Compartment Syndrome and if the clinical symptoms and signs suggestive of Compartment Syndrome, fasciotomy could be done as an emergency.

If there are equivocal clinical findings, if patient is unconsicious, measure the compartment pressure. If it is more than 30mmHg, subject the patient for fasciotomy. If it is less than 30 mmHg, intra compartmental pressure should be monitored frequently. If one the reading shows >30mmHg do fasciotomy. If it is <30mmHg monitor the patient.



It is because; tissue can tolerate the ischemia for a certain period of time. During this period, if the offending agent has been removed and blood flow to the tissues ensures, tissue can revert back to normal homoestasis. If the period goes beyond critical time, tissue changes become irreversible. Even blood flow is established beyond that critical period, tissue changes will not become reversible.

In a study conducted by Whitesides and his colleagues stated that critical pressure at which fasciotomy should be done is 10-30mmHg of patients DBP. Another study conducted by McQueen and his colleague in canine, stated that critical pressure at which fasciotomy should be done is 30mmHg which is difference between the pressure in intra compartment and patient DBP.

INDICATION OF FASCIOTOMY AS GIVEN BY MUBARAK AND HARGENS FOLLOWS.

- In patient with unequivocal clinical signs and symptoms with normal blood pressure, if intra compartment pressure is >30mmHg.

- In patient with elevated intracompartmental pressur whose duration is not known (or) if duration is more than 8 hours.

- ❖ If Intracompartmental pressure is >30mmHg and if the patient is unconscious (or) mental status is unreliable.

- ❖ In hypotensive patients with a intracompartmental pressure of >20mmHg.

Amount of pressure, a limb can with stand depends upon,

- Nature of tissue
- Blood pressure of the part limb
- Status of the blood vessel

Neurons is the first one to be affected by compartment syndrome, because neurons cannot withstand the ischemia even for a minimal duration. Muscle is the last one to be affected. So if the patient is having paresis/ paralysis, compartment syndrome already in advanced condition.

Arato and his colleague stated that decision regarding fasciotomy can also made by combination of compartment pressure measurent and oxygen saturation, If both of them are normal, conservative management can be offered.

But in case of hand compartment syndrome. Critical pressure at which fasciotomy to be done should be relaxed. Even if the pressure is >15 mmHg fasciotomy should be offered,

When fasciotomy is offered for a neglected compartment syndrome, it is of no use at all because,

- Muscle was already necrosed. When necrosed muscle is exposed to exterior, it predisposes to infection and sepsis will results.
- It increases morbidity and mortality in that patient.

Because of this, fasciotomy is usually not offered to a patient in advanced stages of compartment syndrome. Instead if let as such, it will heal by fibrosis and results in Volkman's contracture. Patient can tolerate the morbidity produced by Volkman's Contrcture than morbidity produce by fasciotomy in a late stage of Compartment syndrome.

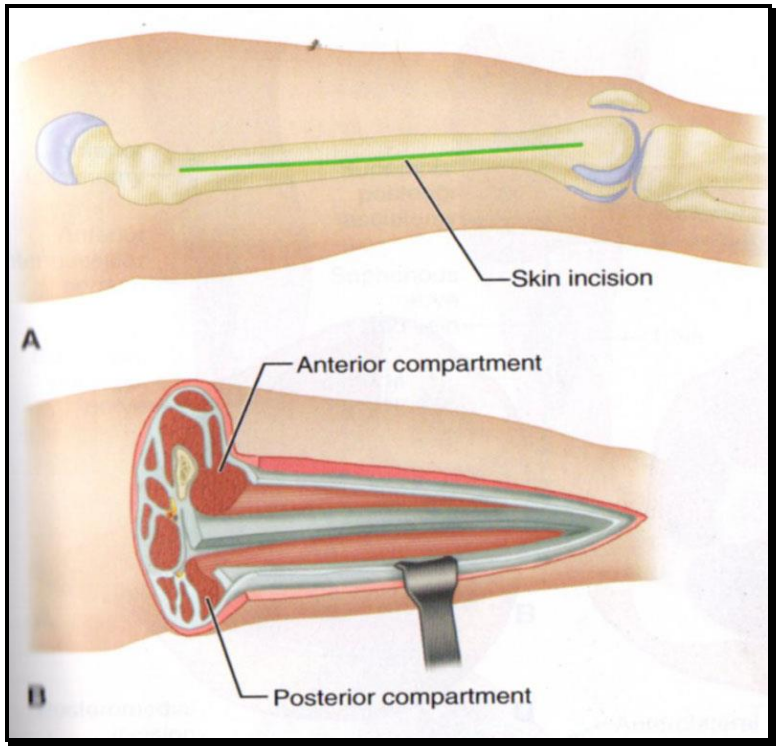
When a surgeon approaches a patient with vessel injury or acute ischemia he/ she should kept in mind that patient may develop reperfusion injury. So once the perfusion is established, prophylactic fasciotomy should be done.

Fasciotomy should be offered in high risk groups, where

- ❖ Patients with ischeamia who presented late.
- ❖ Patients with hemodynamically unstable whose clinical signs ae equivocal
- ❖ Combined vessel occlusion
- ❖ Those who need femoral and popliteal vein ligation.

FASCITOMY FOR ACUTE COMPARTMENT SYNDROME FOR THIGH

- ❖ Fasciotomy should be done under spinal anaesthesia.



- Under, Spinal anaesthesia, patient in supine position parts painted and drapped.
- Make a skin incision at lateral border of thigh, extending from the greater trochanter to lat. Condyle of the femur.
- Subcutaneous tissues are retracted using Langenbch retractor and expose the iliotibial tract.
- Make an incision in the iliotibial tract extending from greater trochanter to lower one third of thigh and vastus lateralis muscle is exposed.
- Carefully retract the vastus lateralis medialy to expose the lateral intermuscular septum.
- Perforator vessels are usually encountered which is identified, divided and ligated with suture.
- Expose the lateral intermuscular septum for its whole length.
- Incise the intermuscular seption procximally and distally.

Here both anterior and post compartment are released. In case of compartment syndrome involving the medial compartment, longitudinal skin incision was made and deeped.

- Deep fascia is incised in longitudinal fascir both procximally and istally.
- Addictor compartment is decompressed.

Make the wound left open.

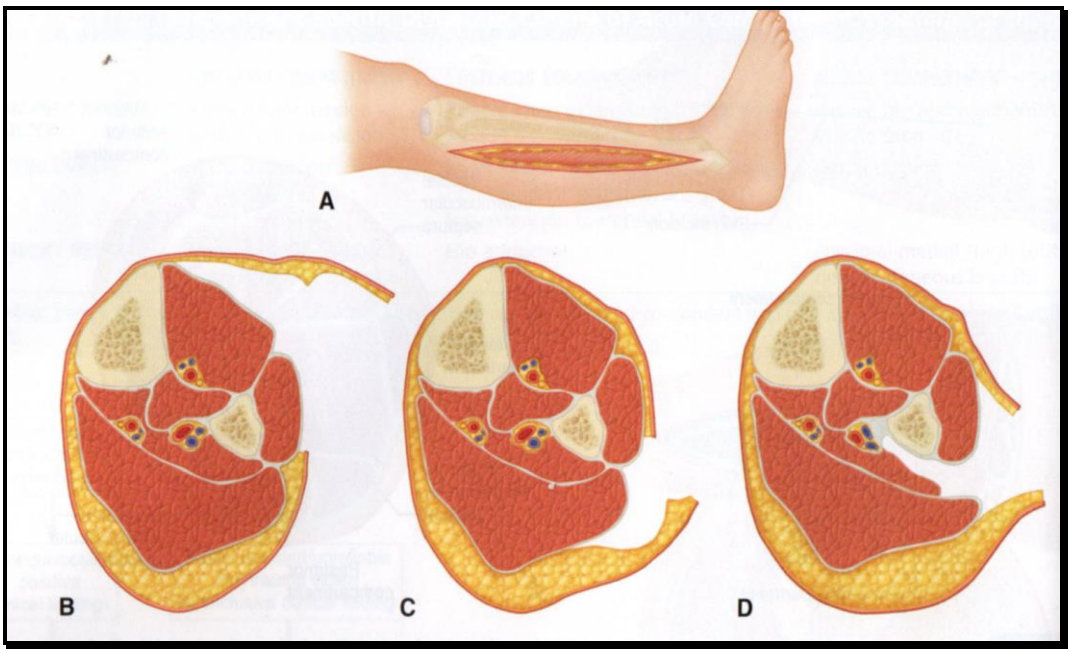
Post operatively

1. Correction of anaemia
2. Proper antibiotics,
3. would care is important

Wound should be reexamined for viabity of muscles. If there is any necrosis of muscle, patient should be taken up for debridement. If muscle viability is good, daily dressingis is advised. Skin is closed either by secondary intention (or) by secondary suturing. Sometimes patients may need SSG.

FASCIOTOMY FOR LEG

Single Incision



- Fasciotomy should be done under spinal anaesthesia.
- Under Spinal anaesthesia, patient in supine position parts painted and drapped.
- Make a skin incision at the lateral aspect of skin parallel to fibular bone extending from the neck of fibula to just above lateral malleolus.
- Incision is deepened. Skin flap was raised from the deep fascia till the anterior surface of tibia.
- Make an incision in the deep fascia over the Tibialis anterior and peroneus longus muscle. Thus the anterior

compartment and posterior compartment are decompressed.

- ❖ Similar skin flap was raised inferiorly, from the deep fascia till the middle of the leg exposing the deep fascia of of the superficial posterior compartment.
- ❖ Incise the deep fascia of superficial post compartment. So that this compartment is decompressed.
- ❖ Now dissection should be carried in betweens superficial posterior compartment and lateral compartment.
- ❖ Identify “Flexor Hallucis longus” and detach it from the fibular bone.
- ❖ Muscle and the peroneal artery and vein should be retracted posteriorly.
- ❖ Incise the fascia of the deep posterior compartment.
- ❖ Make the would left open and dressing is applied.

Post operatively

1. Correction of anaemia

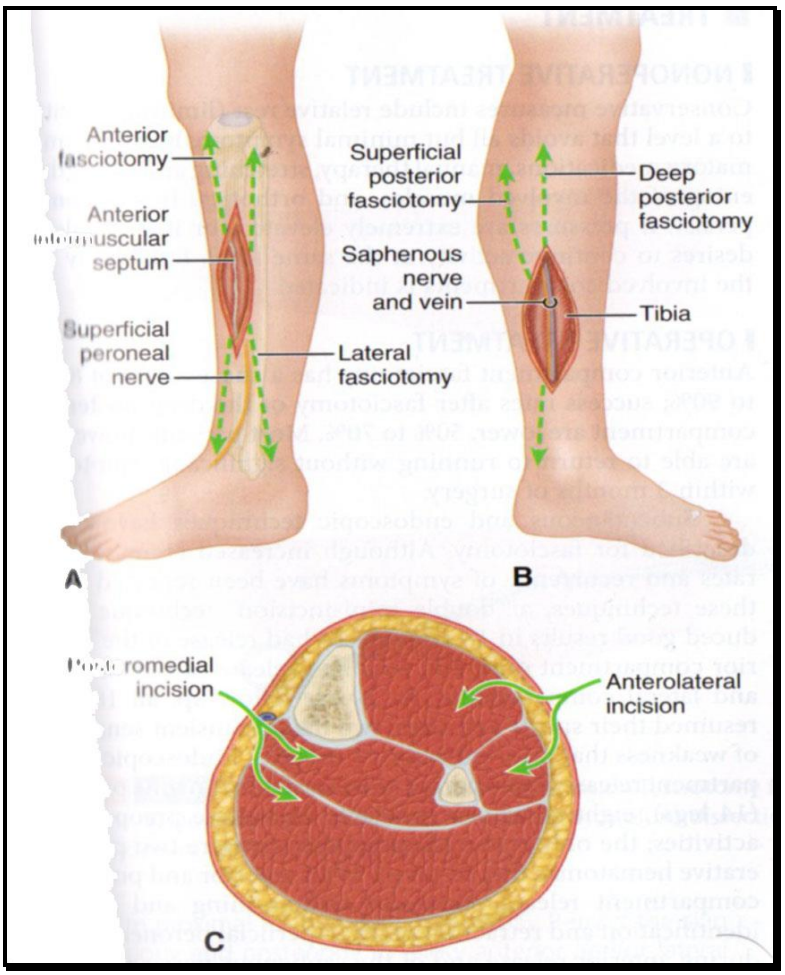
2. Proper antibiotic

3. would care is important

Wound should be reexamined for viabity of muscles. If there is only necrosis of muscle is present, patient should be taken up for debridement, since necrosed muscle is prone to get infected. If muscle viability is good, daily dressingis is advised. Skin is closed either by secondary intension (or) by secondary suturing. Sometimes patients may need SSG.

DOUBLE INCISION

- ❖ It is ideal to do the fasciotomy under spinal anaesthesia.
- ❖ Under spinal anaesthesia, patient in supine position, parts painted and drapped.



- Make a longitudinal skin incision starting from 5 cm below knee joint to 4cm proximal to ankle joint and midway between tibial crest and fibular bone.

- An incision is deepened and exposes the deep fascia.

- Anterior compartment should be released by incising the deep fascia over the anterior compartment.

- Similarly Lateral compartment should be released by insing the deep fascia over the lateral compartment.

- Another longitudinal skin incision was made 2cm behind the posterior border of the tibia and incision in deepened. Expose the deep fascia.

- Identify the saphenous vein and saphenous nerve and retract it anteriorly.

- Make a longitudinal incision on the deep fascia over the gastronemios and soleus muscle and decompression of superficial posterior compartment should be ensured.

- Similarly make a longitudinal incidion on the deep fascia over the “Flexor Digitorum Longus” muscle and decompression of deep posterior compartment should be ensured.

- Wound was left open and dressing is applied.

Post operatively

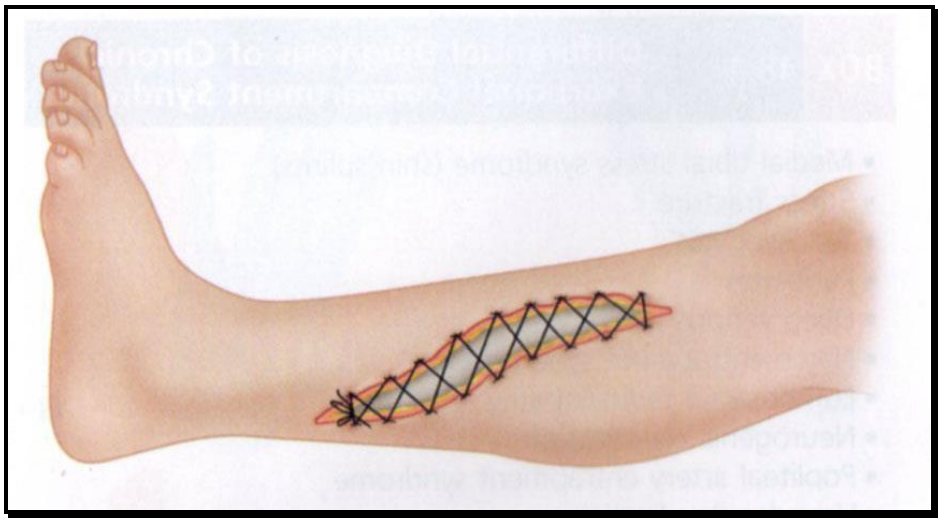
1. Correction of anaemia

2. Proper antibiotic

3. would case is important

Wound should be reexamined for riabity of muscles. If there is only necrosis of muscle is present patient should be taken up for

debridement, since necrosed muscle is prone to get infected if muscle viability is good, daily dressingis is advised. Skin is closed either by secondary intension (or) by secondary suturing. Sometimes patients may need SSG.



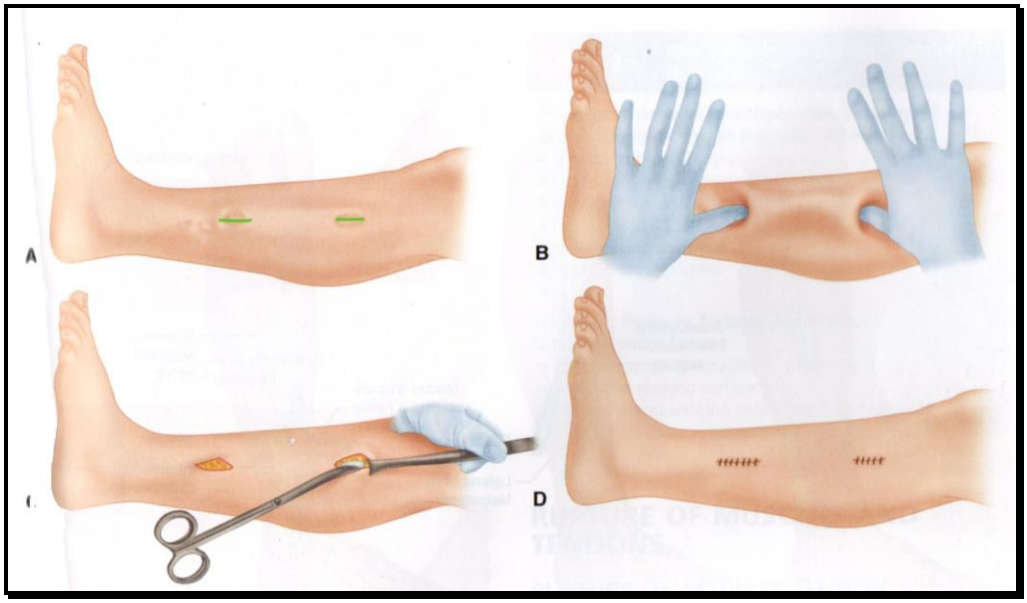
DOUBLE MINI INCISION FASCIOTOMY FOR CHROMIC ANTERIOR COMPARTMENT SYNDROME

- Under spinal anaesthesia, patient in supine position parts painted and drapped.

- Two 2 cm skin incision was made on the anterolateral aspect of leg one is 5cm below the knee joint and another is 10cm proximal to ankle joint. The distance between the two incision should be 15cm.

- Skin flap should be raised superior and inferioly.

Identify the deep fascia over the Anterior Compratment & Lateral Compartement incise separately. So that both these compartments are decompressed.

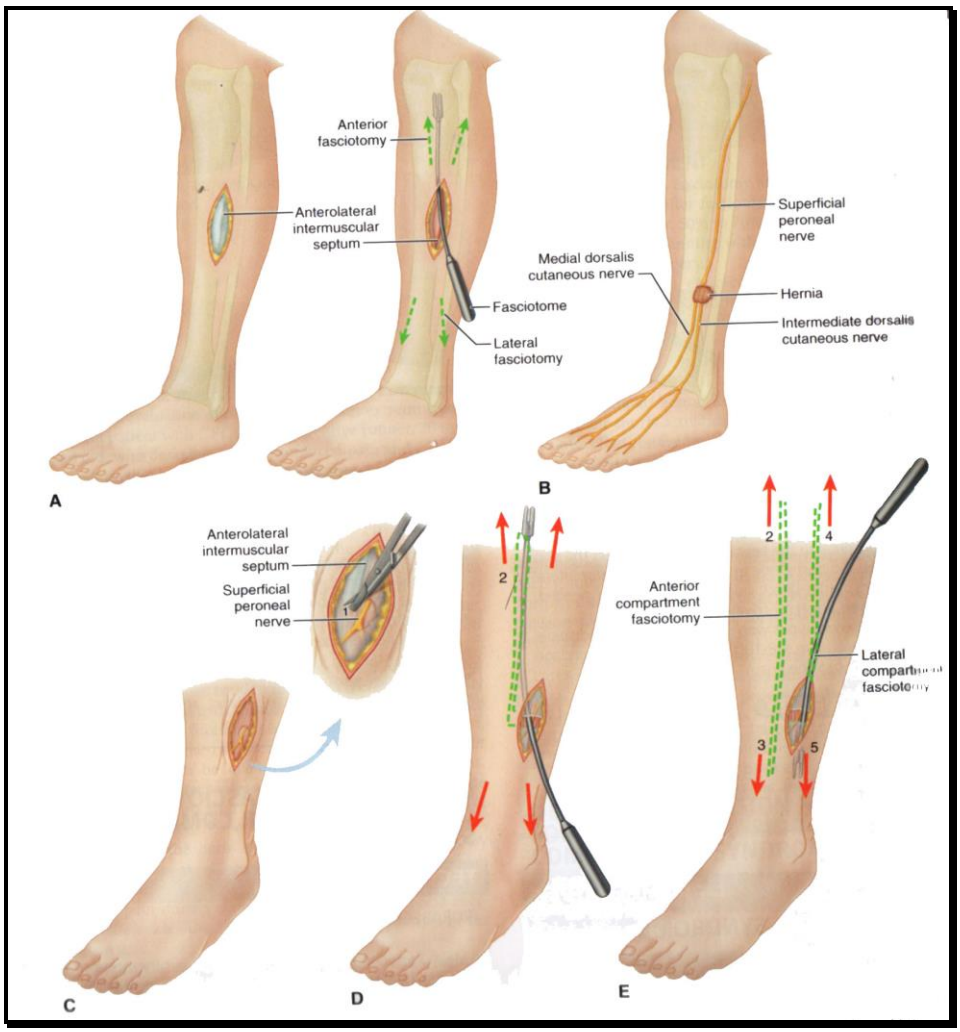


Post Operatively

Patient should be instructed to keep the leg above the level of heart to avoid edema. Initially passive movement of the ankle and knee joint should be adviced which should be followed by active movement. Patient should be instructed to walk using crutches. If these are tolerated, then day to day activities to be encouraged in 3-4 wks post operatively.

SINGLE INCISION FASCIOTOMY FOR CHRONIC ANTERIOR AND LATERAL COMPARTMENT SYNDROME

- Under spinal anaesthesia, patient in supine position, parts painted and drapped.



- Longitudinal skin incision of 4cm was made midway between the crest of the tibia and fibular bone and incision is deepend.
- Superficial peroneal nerve and anterior intermuscular septum should be identified.
- Skin edges should be retracted.
- Fasciotome should be passed into anterior compartment parallel to tibialis anterior.

- Similarily fasciotome should be passed into lateral compartment parallel to fibula.

- Hemostatsis should be achieved.

Wound should be closeed in layers subcutaneous was closed sing catgut skin was closed using ethilon.

Post Operatively

Patient should be instructdt o keep the leg above the level of heart. Initially passive movement of the ankle and knee jkoint should be adviced followed by active movement. Patient should be instructed to walk using crutches. If these are tolerated, then day to day activities to be encouraged in 3-4 wks post operatively.

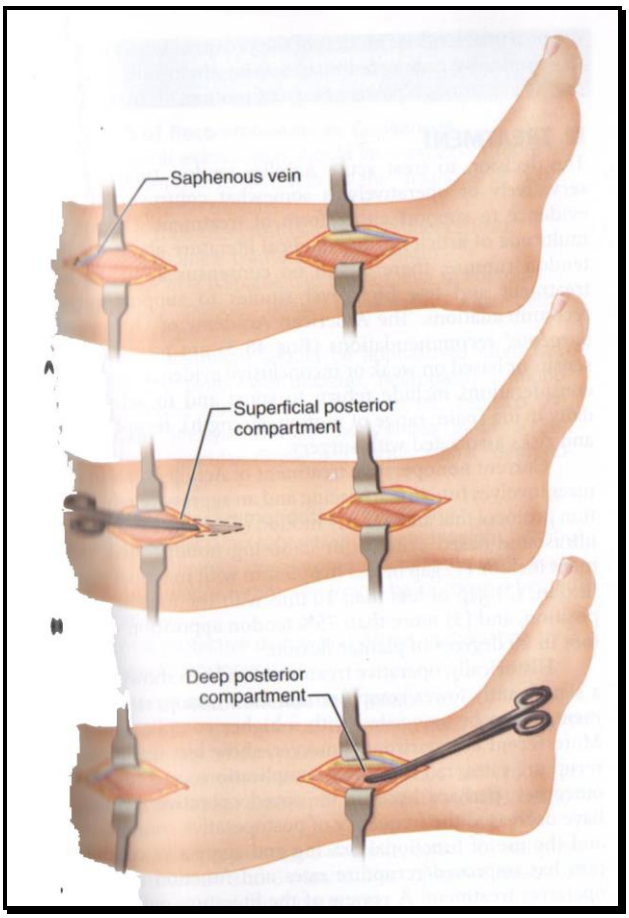
***DOUBLE INCISION* FASCIOTOMY**

- Under spinal anaesthetia, patient in supine position, parts painted and drapped.

- Two separate longitudinal skin incision of 5cm was made 1cm post post to tibial medial boarded.

- Incision was deepened and indentify the deep fascia.

- Incise the deep fascia over the superficial posterior and deep posterior compartment.

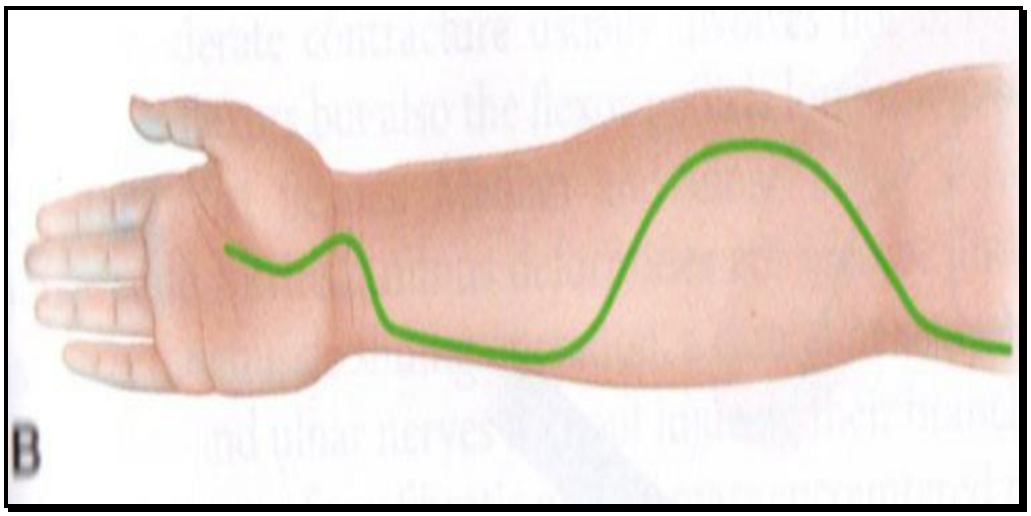


- Ensure proper decompression of the both superficial and deep posterior compartment.

- Perfect hemostasis achieved. Wound should be closeed in layers subcutaneous was closed sing catgut skin was closed using ethilon.

FOREARM FASCIOTOMY

- Under supraclavicular block, patient in supine position with corresponding upper limb is abducted and extended. Parts painted and drapped.



- Start an incision medial to biceps tendon, crossing the elbow crease obliquely.
- In forearm, incision should be curvilinear around the lateral border of the forearm and brought the incision distally.
- Incision should be extended into palm crossing the wrist at an oblique angle.
- Incision should be deepened deep fascia should be exposed.
- Incise the deep fascia thorugh out its entire length and there by superficial compartment is released.
- For decompression of deep compartment, identify the “flexor carpi ulnaris muscle” and ulnar vessesls and nerve should be retracted medically. Identify the median nerve and “flexor

digitorum superficialis muscle" and retract it medially to expose the "flexor digitorum profundus".

- Incise the fascia over the "flexor digitorum profundus muscle" there by releasing deep poserior compartment.

- Usualy volar compartment decompression is sufficient to decompress the dorsal compartment also. If clinician thinks that decompression of compartment is not enough, decompress it through separate incision.

- For extensor compartment decompression, make an longitudinal incision, starting just distal to lateral epicondyle and the incision should run between "extensor carpi radialis brevis muscle" & "extensor digitorum muscle".

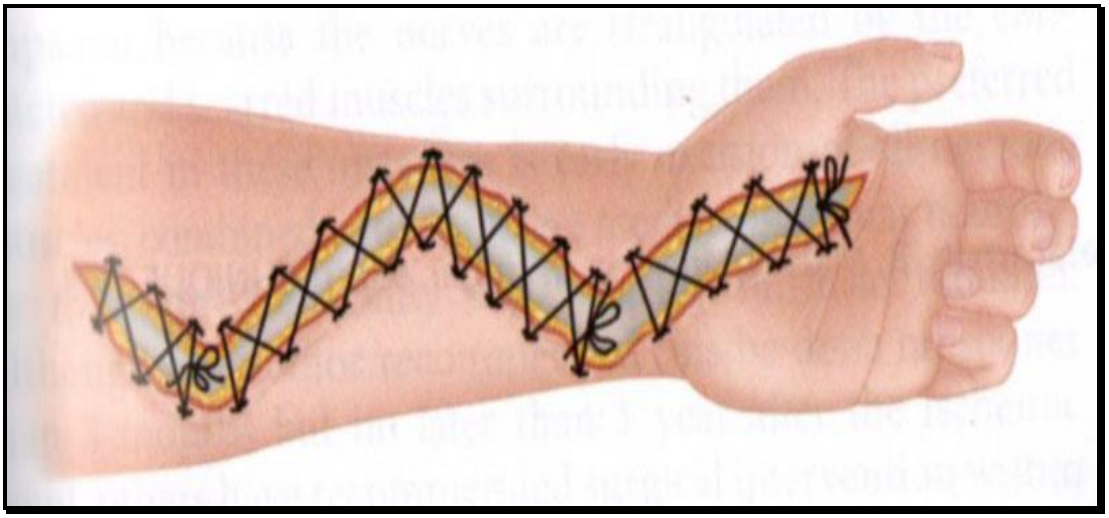
- Fascia on the "Henry's mobile wad" and the extensor retinaculum should be released.

Important intra operative aspects in forearm fasciotomy

- Look for brachial artery to rule out any internal injury.

- Identify the medial nerve and examine it along its entire course.

- If there is any fracture, do open reduction and internal fixation of the fractured bone.
- If nerves, vessels are exposed externally, close it with flap cover.
- Make the would left open and dressing should be done.

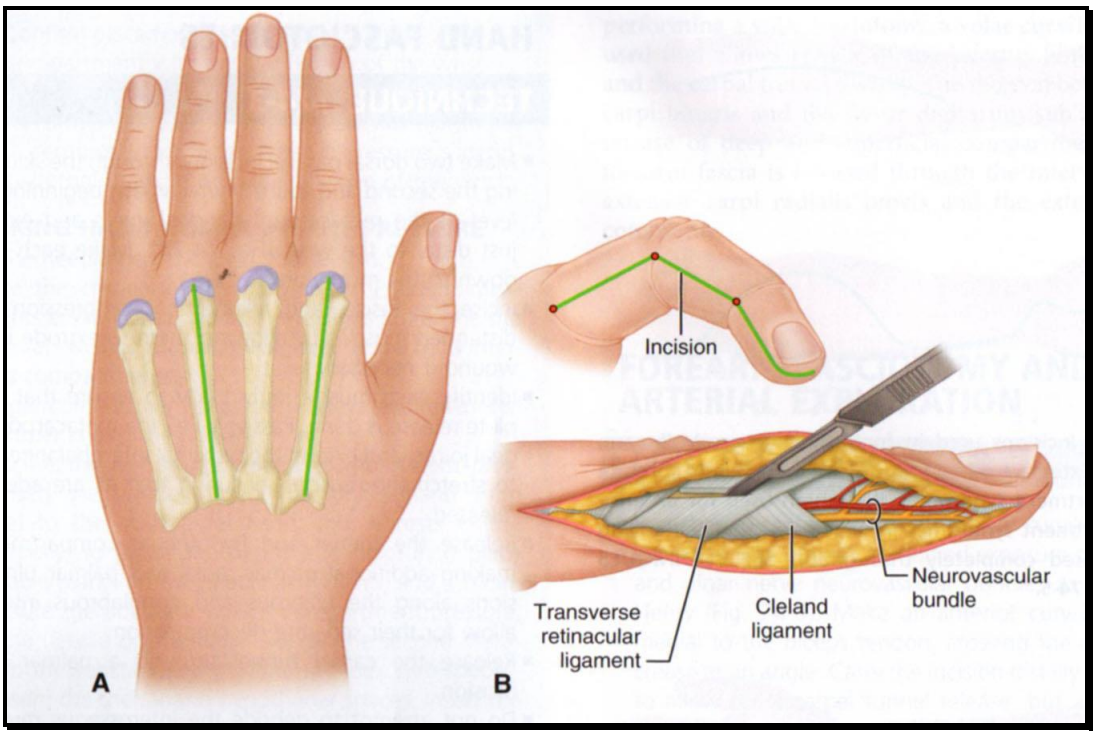


Post Operatively

The limb should be in elevated portion which will reduce the edema. If the woud is healed well, make it close by secondary intension and it can be closed by delayed primary closure.

HAND FASCIOTOMY

- Under Supraclavicular / axillary block, patient should be in supine position; corresponding uppr limb is abducted and extended. Parts painted and drapped.



- Make two longitudinal incisions the dorsum of hand over the 2nd and 4th metacarpal bone extending from the knuckle to wrist.

- Deepened the incision and incise the deep fascia and release the pressure.

- Incase of finger, make an incision along the axis of finger. In case of index and middle finger, incision should be placed on medial surface and in case of ring and little finger incision should be placed in lateral surface.

- In case of thenar and hypothenar compartment syndrome release the corresponding compartment adequately.

- If any ncecrosis is found, debridement should be done.
- Keep the wound left open.
- Do dressing.

Post Operatively

The limb should be in elevated portion which reduce the edema. It the wound is healed well, make it close by secondary intention or it can be closed by delayed primary closure.

PLANTAR FASCIOTOMY

Using Single Incision

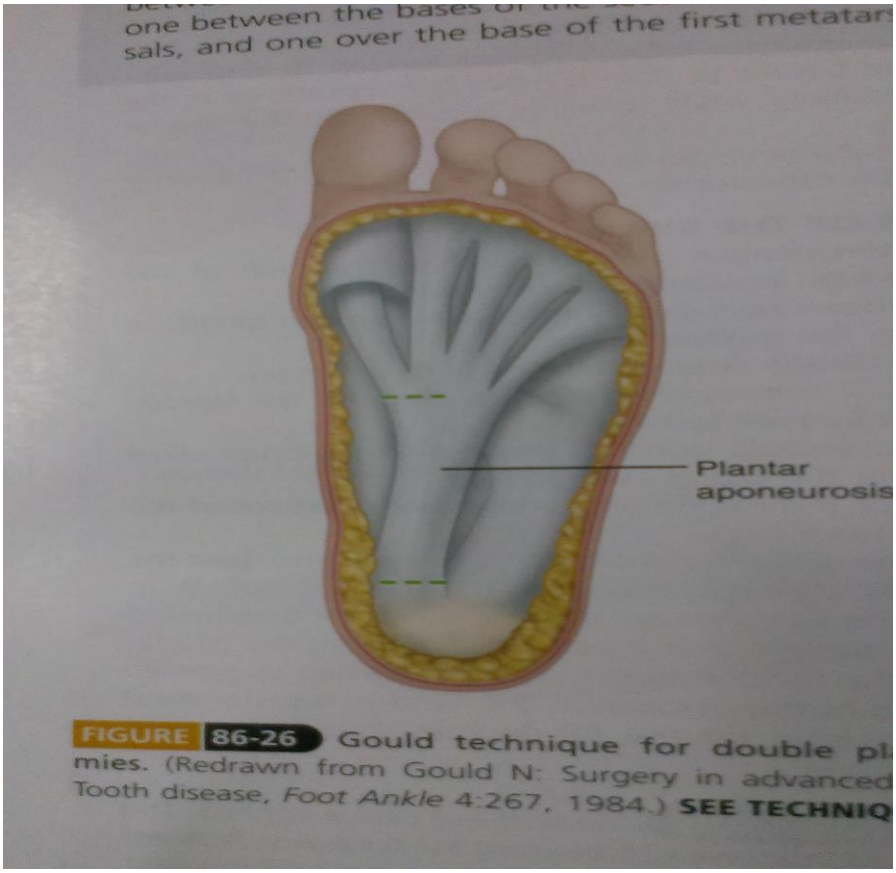
- ❖ Under SA, patient in supine position, parts painted and drapped.
- ❖ An incision was made in the medial aspect of foot for 2 cm.
- ❖ Dissection should be done superiorly and inferiorly and expose the plantar fasica. It should be incised. Once a plantar fascia is released incised, pressure will be released.

Post Operatively

Patient should be instructed to keep the leg above the level of heart. Initially passive movement of the ankle and knee jkoint should be adviced followed by active movement. Patient should be

instructed to walk using crutches. If these are tolerated, then day to day activities to be encouraged in 3-4 wks post operatively.

USING DOUBLE INCISION



- Under SA patient in supine position, parts painted and drapped.
- An incision was over the calcaneal tubercle and release the plantar aponeurosis.
- Another was made along the medial border of foot. Identify the neurovascular bundle and retract it superiorly. Dissection

should be carried out till the aponeumosis was visualized. Incise the aponeurosis. So that it protrudes into the wound.

- ❖ Make the wound left. Do the dressing.

Post Operatively

Patient should be instructed to keep the leg above the level of heart. Initially passive movement of the ankle and knee jkoint should be adviced followed by active movement. Patient should be instructed to walk using crutches. If these are tolerated, then day to day activities to be encouraged in 3-4 wks post operatively.

A WORD ON WOUND HEALING

TYPES OF WOUND HEALING

Healing by Primary intention

Healing by primary intention occurs when wound edges are approximated shortly after the primary wound has been occured. Epithelization and contraction have little to do with the healing by primary closed wounds, even though minimal epithelization occurs within 24 hours and seals the wound from bacterial contamination.

Healing by secondary intention

This is healing by natural biological processes without surgical intervention, which usually occurs in large wounds associated with skin and soft tissue loss. Although epithelization and collagen deposition are involved, contraction is the most important phenomenon in the spontaneous closure of large open wounds, Unless contraction occurs and brings dermal structures together, the granulating surface is covered only by a layer of epithelial cells that are useless in providing any coverage with strength and integrity.

Delayed primary closure

Closure of grossly contaminated incisions/wounds should be delayed, allowing time for host inflammatory and immune responses to control contamination. Most significant is that delayed primary closure does not delay the development of wound strength.

COMPARTMENT SYNDROME AFTER ARTHROSCOPY

After knee arthroscopy some of the patients may tend to develop anterior compartment syndrome. Traditional way of treating this is fasciotomy. Kapper and his colleagues advised to monitor the patient for development of clinical symptoms and signs of compartment syndrome and compartment pressure measurement

once in every 6-8hrs for 48 hours. During this period, if the patient develops compartment syndrome or if the compartment pressure is >30 mmHg, decompression of the compartment s advised.

HYPERBARIC OXYGEN THERAPY

The use of hyperbaric oxygen (HBO) raises the dissolved oxygen saturation in plasma from 0.3% to nearly 7%. This rise in oxygen saturation increases the interstitial diffusion distance of oxygen four to fivefold.

The broadening use of transcutaneous oximetry has permitted evaluation of patients who will likely benefit from hyperbaric oxygen.

Hyperbaric oxygen can be inspired by a special pressure vessel known as recompression chamber. It can be used to reduce the morbidity in patients with compartment syndrome.

REHABILITATION THERAPY

- Patient usually needs physiotherapy in the early post operative period. Initially there should be assive flexion of joints proximal and distal to area of fasciotomy. This will prevent joint stiffness and contractures.

- Slowly encourage the patient to walk using walkers, with another person support. Pain should be adequately control during the postop period which will reduce the morbidity in the patient.

- If the tolerates, gradually trained the patient by teaching aerobic exercises. e.g walking individually i.e without support, jogging and squatting.

- Wound should be taken proper care. Daily dressing should be done. If there is any slough, debride it adequately. Do culture and sensitivity from the wound and provide appropriate antibiotics.

- Encourage the patient to swim, do cycling and for a sports person initiate the activities which are specific to their sports.

ANALGESICS

It is an integral part of in the management of compartment syndrome. Its value is crucial in the management of rehabilitation phase.

It can be achieved by

- Through Epidural Catheter

- Intravenous Analgesics (e.g. tramadol, pethidine, ketorolac)

- Intra muscular Analgesics (e.g. voveron)

- Oral Analgesics (e.g. ibuprofen)

Initially it is better to start with intravenous analgesics. Once the pain is adequately controlled and during the late post operative period, it can be changed into oral analgesics.

IF COMPARTMENT SYNDROME IS NEGLECTED

- In initial stages permanent nerve damage to the nerve happens which will result in prescence of constant pain, increased sensitivity to pain and ischeamic contractures.
- If debridement is attempted, infection and septicemia will result.
- Acute Renal failure and sometimes permanent kidney damage occurs.

MATERIALS AND METHODS

TYPE OF STUDY

Retrospective and Analytical study

STUDY APPROVAL

Prior to commencement of this study , Ethical Committee of Rajiv Gandhi Govt.Gen.Hospital and Madras Medical College had approved the thesis protocol.

PLACE OF STUDY

Rajiv Gandhi Govt.Gen.Hospital and Madras Medical College,Chennai.

PERIOD OF STUDY

One year duration starting from October 2012 to September 2013.

SAMPLE SIZE

50 cases

SELECTION OF PATIENTS

a) Sampling method

Random Sampling Method

Inclusion criteria

1) Patients who were diagnosed as Acute compartment syndrome.

Exclusion criteria

Patients with chronic compartment syndrome and chronic exertional compartment syndrome.

ETHICAL CONSIDERATION

All the patients/ legal guardians were given an explanation of the study and about the investigative and operative procedures with their merits and demerits, expected results, and possible complications. If he/she agreed then the case had been selected for this study. The study did not involve any additional investigation or any significant risk. It did not cause economic burden to the patients. The study was approved by the institutional review board prior to commencement of data collection. Informed consent was taken from each patient/guardian. Data were collected by approved data collection form.

DATA COLLECTION

Data were collected by pre-tested structured questionnaire. Data were collected from all the respondents by direct interview after getting informed written consent from them or from their legal guardian.

STUDY PROCEDURE

The data for the study was obtained from patients with a diagnosis of compartment syndrome on clinical evaluation and who are admitted at Rajiv Gandhi Government General Hospital. Patients presenting with signs and symptoms of Acute Compartment Syndrome admitted during October 2012 to September 2013 at Rajiv Gandhi Government General Hospital, were counseled for investigation for Acute Compartment Syndrome. Of those, 50 patients admitted with Acute Compartment Syndrome chosen for the study group.

All the patients were studied and clinical findings were recorded as per proforma case sheet. Necessary investigations were done and analyzed.

Name, age, occupation, socioeconomic status, residence were recorded in the proforma case sheet. The presenting complaints and details were recorded in chronological order.

Detailed physical examination including nutritional status, built, status of vascular system and neurological system were recorded. Detailed local examination of involved part done

INVESTIGATIONS DONE INCLUDES

1) Routine blood investigation: Complete blood count

2) Routine urinalysis: Albumin, sugars, deposits

3) Blood urea and serum creatinine

4) Lipid profile

5) Radiograph of affected part.

6) Biopsy of the affected part

7) Arterial and venous Doppler study.

Patients were initially stabilized by intravenous fluids and proper antibiotics. Blood and blood product transfusion was done if needed. Serial monitoring of hemoglobin and renal function tests were done. Initial symptom of the patient will be parasthesia of the involved limb. Later patient was investigated with arterial and venous Doppler to know the vascularity status. Then compartment syndrome was managed with adequate fasciotomy. Later patients were managed by regular dressings. Once wound was ready, secondary suturing or split skin graft was done. If fracture was present, it was managed either by open reduction and internal fixation or application of external fixator. If compartment syndrome

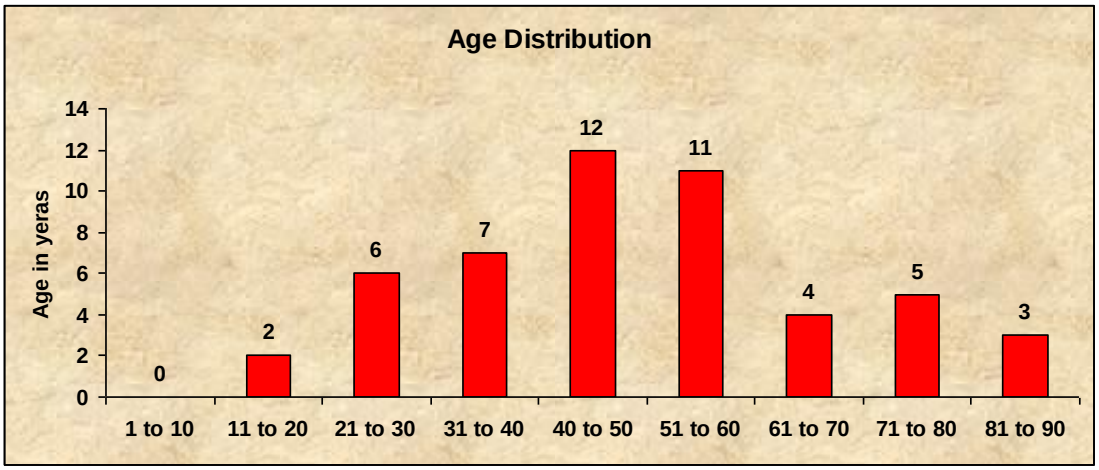
is due to snake envenomation, anti snake venom was given. If compartment syndrome is due to infection culture and sensitivity from the wound was sent and appropriate antibiotics were provided. If compartment syndrome is due to arterial ischaemia, revascularization was attempted. In this incidence of compartment syndrome with respect to age, limb involvement, region of limb involved, etiology, clinical symptoms and signs were analysed and discussed. And also identify high risk group.

RESULTS & DISCUSSION

Table – 1: Age Distribution

Age (yrs)	No. of Patients	Percentage
1 to 10	0	0%
11 to 20	2	4%
21 to 30	6	12%
31 to 40	7	14%
40 to 50	12	24%
51 to 60	11	22%
61 to 70	4	8%
71 to 80	5	10%
81 to 90	3	6%

Fig-1: Age Distribution

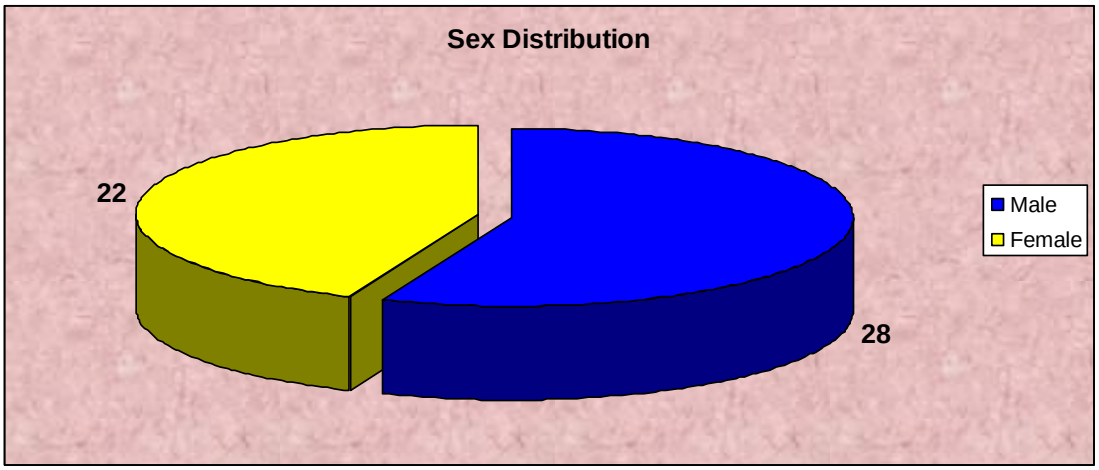


Out of patients with compartment syndrome, the maximum incidence was seen in the age group of 41-50 years and 51-60. The mean age group affected was around 52.

Table-2: Sex Distribution

Sex	No. of Patients	Percentage
Male	28	56%
Female	22	44%

Fig-2: Sex Distribution

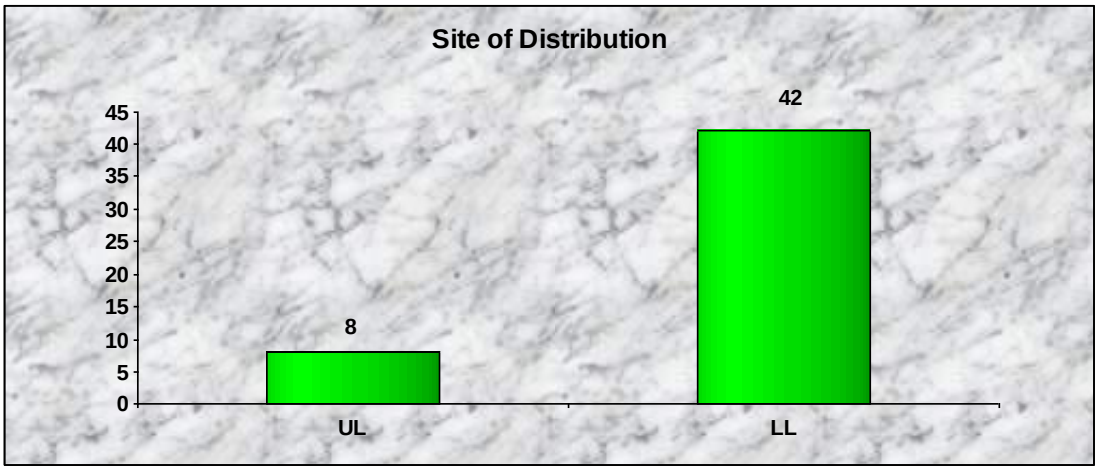


Out of 50 patients with compartment syndrome, 28 patients were males (56%) and 22 patients were females (44%) from the study, the incidence of compartment syndrome is most common in female.

Table-3: Site of Distribution

Site	No. of Patients	Percentage
Upper Limb	8	16%
Lower Limb	42	84%

Fig-3: Site of Distribution

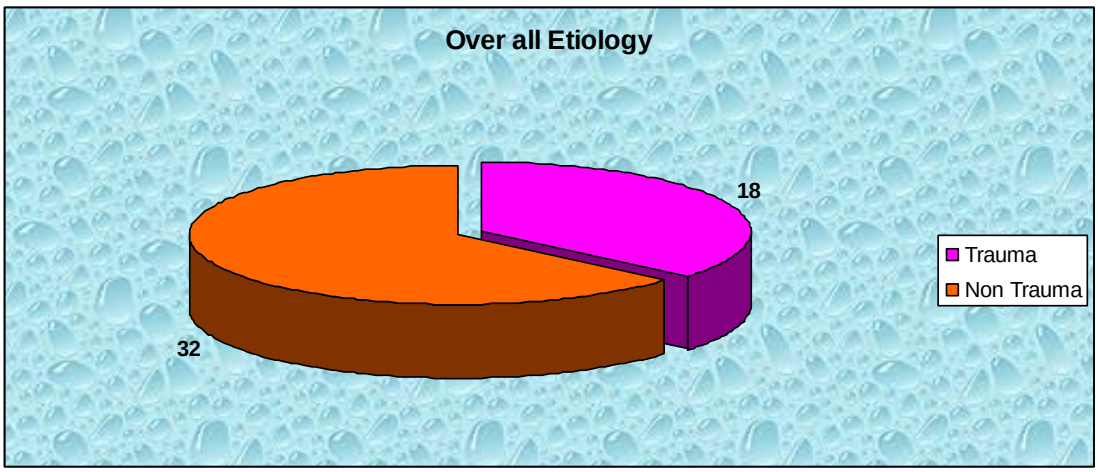


In this series of 50 patients with compartment syndrome, lower limb was the commonest site of involvement (84%) and upper limb being 16%.

Table-4: Overall Etiology

Etiology	No. of Patients	Percentage
Trauma	18	36%
Non Trauma	32	64%

Fig-4: Overall Etiology

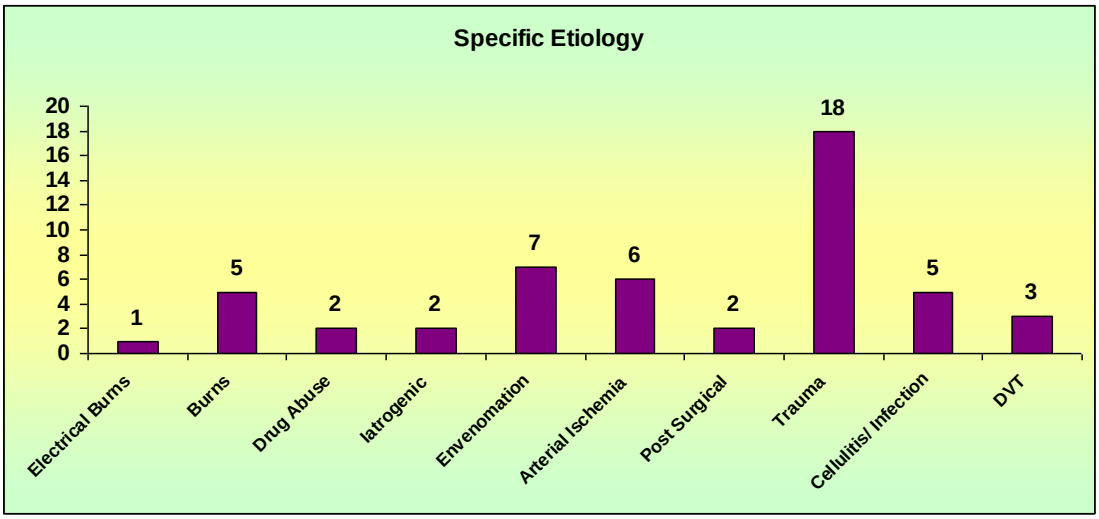


In this series of 60 patients with compartment syndrome, Non traumatic cause (64%) being the most commonest followed by trauma (18%).

Table-5: Specific Etiology

Etiology	No. of Patients	Percentage
Electrical Burns	1	2%
Burns	5	10%
Drug Abuse	2	4%
Iatrogenic	2	4%
Envenomation	7	14%
Arterial Ischemia	6	12%
Post Surgical	2	4%
Trauma	18	36%
Cellulitis/ Infection	5	10%
DVT	3	6%

Fig-5: Specific Etiology

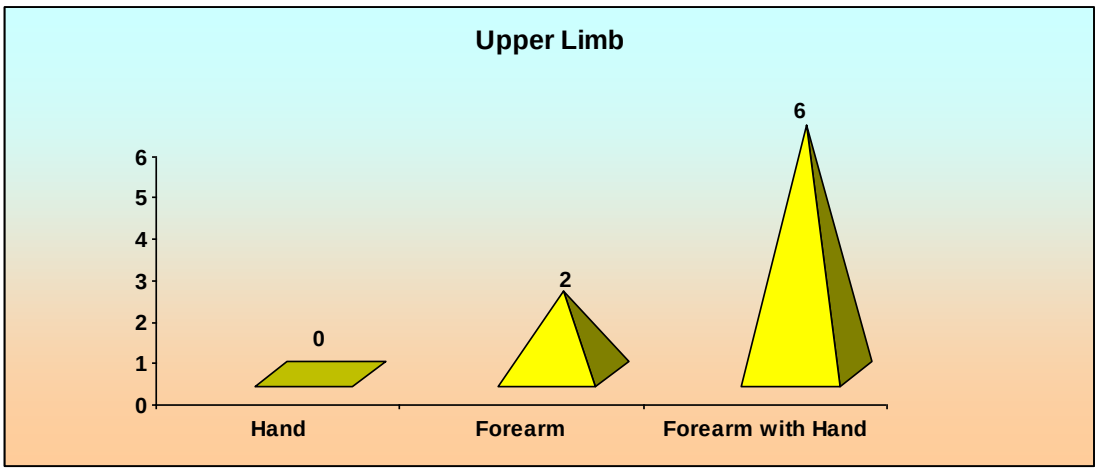


In this series of 50 patients with compartment syndrome, trauma being the most commonest 36%, envenomation 14%, arterial ischemia 12%, Post surgical and iatrogenic 4%, Burns cellulites 10%, DVT 6%, Electrical burns & Drug abuse 1%.

Table-6: Upper Limb Distribution

Upper Limb	No. of Patients	Percentage
Hand	0	0%
Forearm	2	25%
Forearm with Hand	6	75%

Fig- 6: Upper Limb Distribution

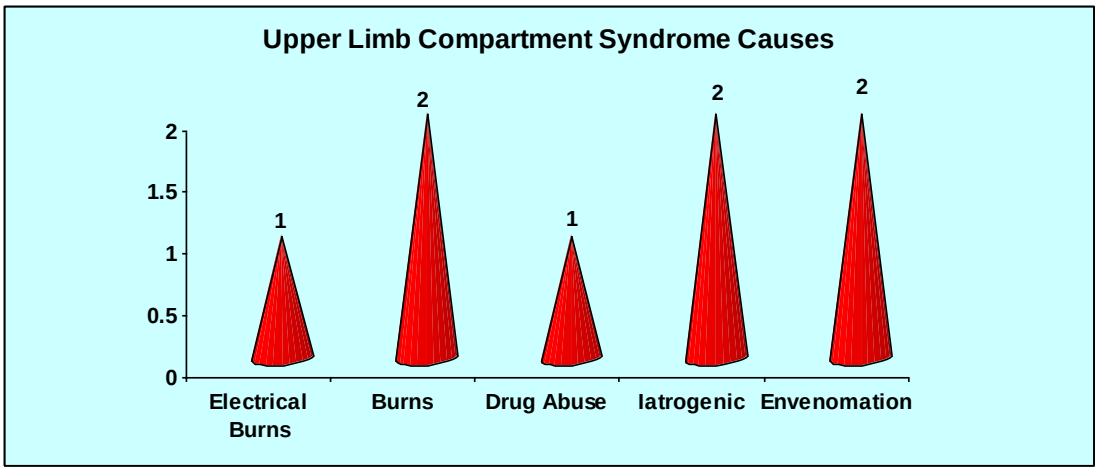


Among 8 patients developed compartment syndrome in upper limb, compartment syndrome develops in forearm with hand in 6 patients (75%) when composed with only 2 patients in forearm (25%).

Table-7: Upper Limb Compartment Syndrome Causes

UL Cases	No. of Patients	Percentage
Electrical Burns	1	12.5%
Burns	2	25%
Drug Abuse	1	12.5%
Iatrogenic	2	25%
Snake Envenomation	2	25%

Fig-7: Upper Limb Compartment Syndrome Causes

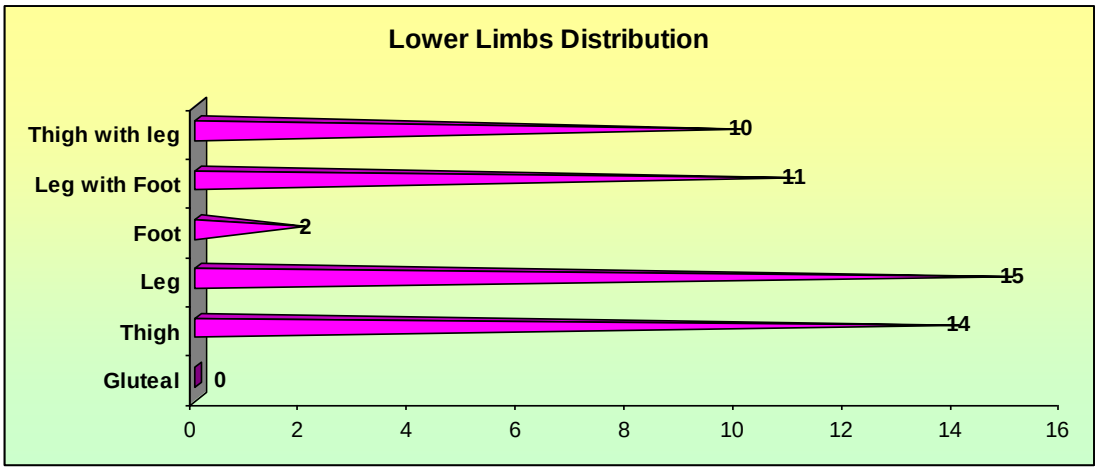


Among 8 patients developed compartment syndrome in upper limb, Iatrogenic cause (due to drug extravasation), snake envenomation and burns share equal percentage (25%) electrical burns and drug abuse being 12.5%.

Table-8: Lower Limbs Distribution

Lower Limbs	No. of Patients	Percentage
Gluteal	0	0%
Thigh	14	9.5%
Leg	15	35.7%
Foot	2	4.8%
Leg with Foot	11	26.2%
Thigh with leg	10	23.8%

Fig-8: Lower Limbs Distribution

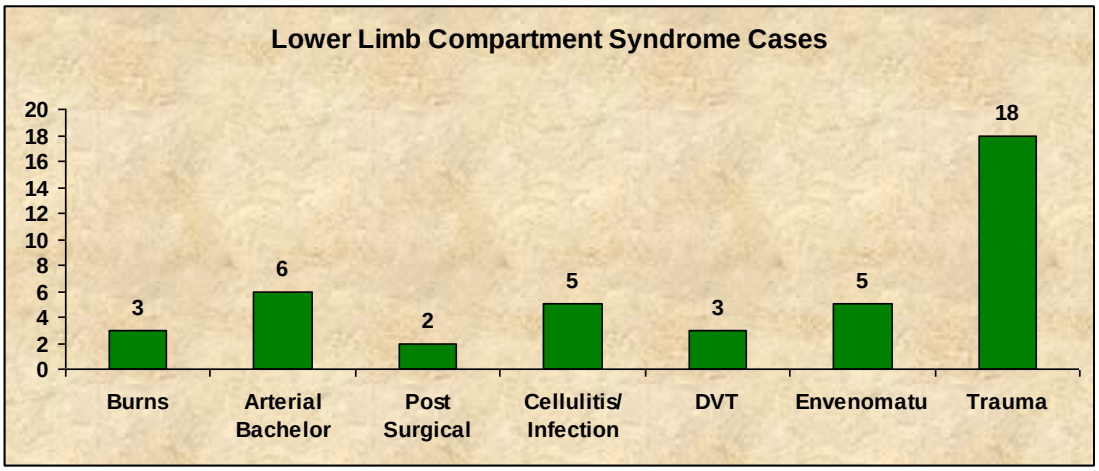


Among patients developed compartment syndrome in lower limb, the most common region affected was leg 35.7%, Leg with foot 26.2%, thigh with leg 23.8%, thigh 9.5%, Foot 2%.

Table-9: Lower Limb Compartment Syndrome Cases

Lower Limb Compartment Syndrome	No. of Patients	Percentage
Burns	3	7.1%
Arterial ishcaemia	6	14.3%
Post Surgical	2	4.8%
Cellulitis/ Infection	5	11.9%
DVT	3	7.1%
Snake Envenomation	5	11.9%
Trauma	18	42.9%

Fig-9: Lower Limb Compartment Syndrome Cases

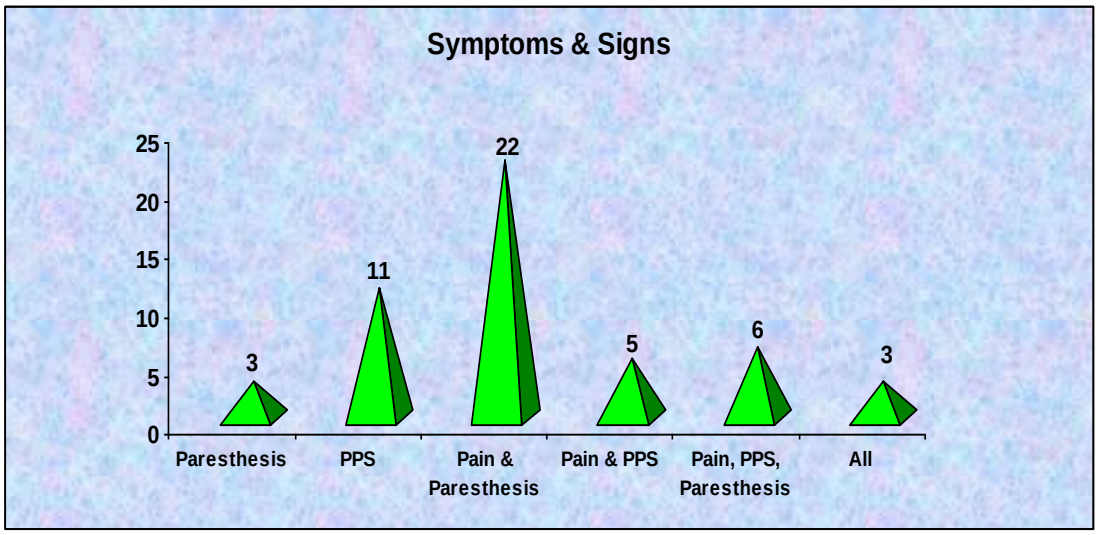


Among 42 patients developed compartment syndrome in lower limb, Trauma being the most common cause (42.9%) followed by Arterial ischemic (14.3%), Envenomation (11.9%), Cellulitis / Infection (11.9%), Burns & DVT being (7.1%). Post surgical (4.8%) due to post varicose vein surgery.

Table-10: Symptoms & Signs

Symptoms & Signs	No. of Patients	Percentage
Paresthesis	3	6%
PPS	11	11%
Pain & Paresthesis	22	44%
Pain & PPS	5	10%
Pain, PPS, Paresthesis	6	12%
All	3	6%

Fig-10: Symptoms & Signs

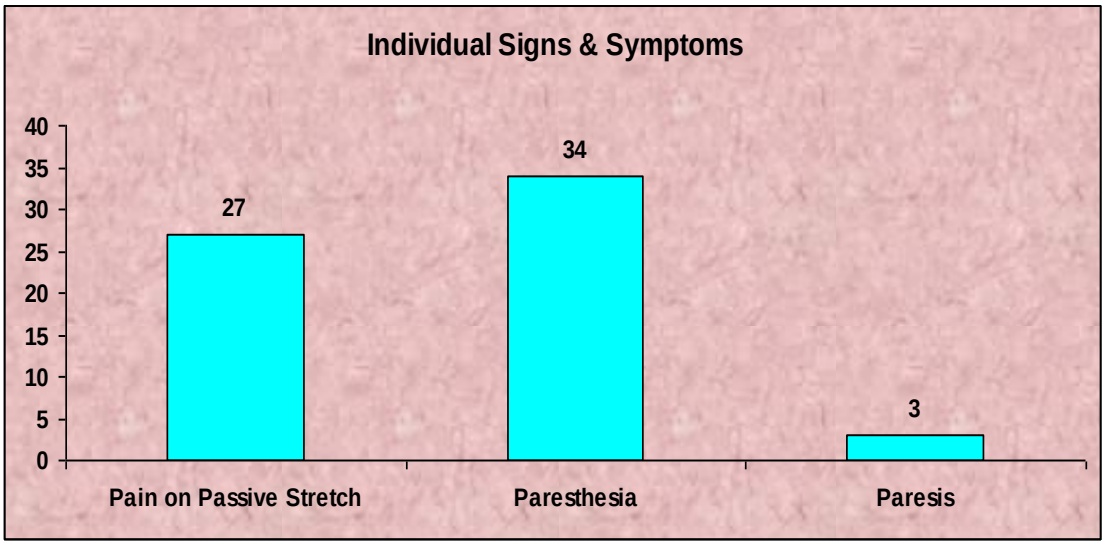


In this series of 50 patients with compartment syndrome, most of the patients presents with pain and paresthesis 44% pain or passive stretching 22%, pain on passive stretching, paresthesis 12%, pain and pain on passive stretching 10%, only paresthesis being 6% with all 4 features shows 6%.

Table-11: Individual Signs & Symptoms

Individual Signs & Symptoms	No. of Patients
Pain on Passive Stretch	27
Paresthesia	34
Paresis	3

Fig-11: Individual Signs & Symptoms

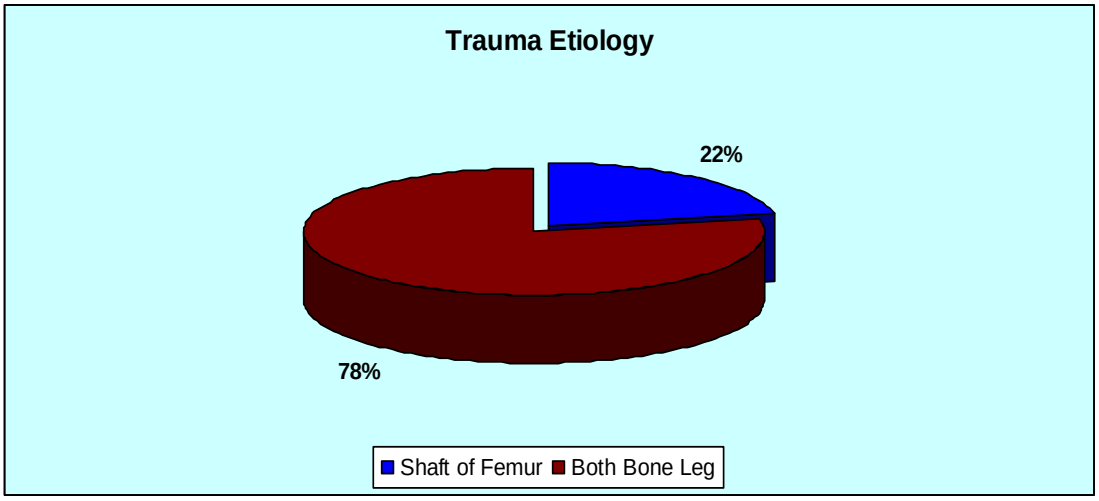


Most of the patients with compartment syndrome predominately having paresthesia and followed by pain on passive stretch of muscle. Paresthesia is due to nerve involvement which is the first sign in compartment syndrome.

Table-12: Trauma Etiology

Fracture	No. of Patients	Percentage
Shaft of Femur	4	22%
Both Bone Leg	14	78%

Fig-12: Trauma Etiology

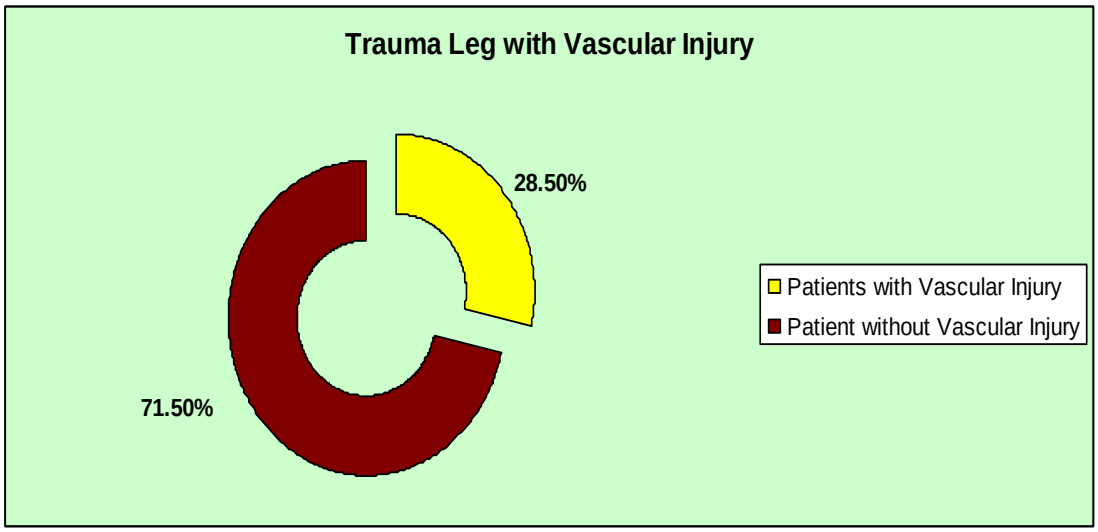


Of the 18 patients admitted with trauma causing compartment syndrome. 4 (22%) patients having shaft of femur fracture and 14(78%) patients having both bone fracture of leg.

Table-13: Trauma Leg with Vascular Injury

Fracture	No. of Patients	Percentage
Patients with Vascular Injury	4	28.5%
Patient without Vascular Injury	10	71.5%

Fig-13: Trauma Leg with Vascular Injury

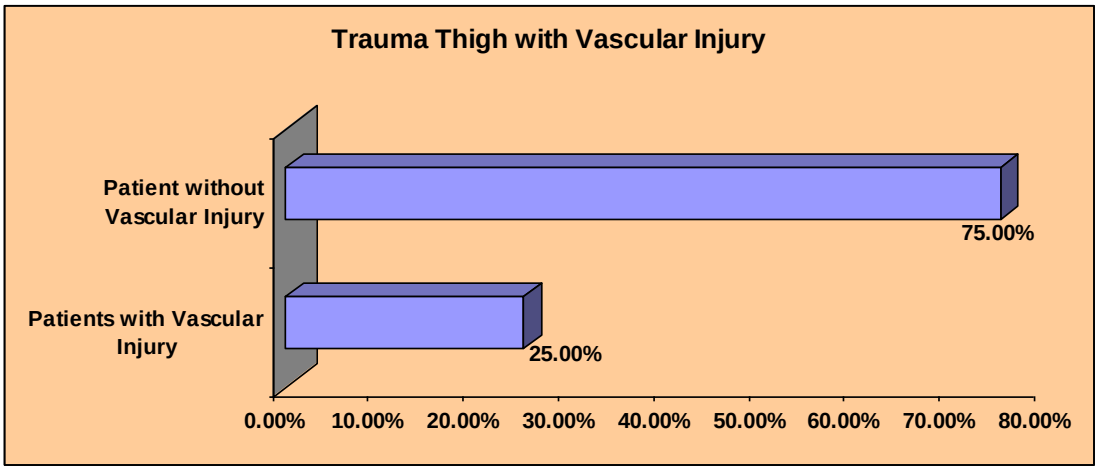


Of the 14 patients admitted with both bone fracture of the leg, 4 patients (28.5%) associated with vascular injury and 10 patients without vascular injury.

Table-13: Trauma Thigh with Vascular Injury

Fracture	No. of Patients	Percentage
Patients with Vascular Injury	1	25%
Patient without Vascular Injury	3	75%

Fig-13: Trauma Thigh with Vascular Injury



Of the 4 patients admitted with shaft of femur fracture, 1 patients (25%) is associated with vascular injury and 3 patients (75%) without vascular injury.

SUMMARY

- Acute compartment syndrome is a surgical emergency.
- This study was conducted on 50 randomly selected patients in one year period and the incidence among male was 56% and female was 44%.
- Commonest age group affected being patients between 4th and 5^{th} decade of life.
- Commonest region affected was lower limb (84%).
- Commonest region involved in upper limb was forearm with hand 75%.
- Commonest cause of upper limb compartment syndrome was introgenic and snake envenomation with each sharing 25%.
- Commonest cause of lower limb compartment syndrome was trauma (42.9%).
- On the whole, commonest over all etiology was trauma (36%).
- Patients with compartment syndrome most commonly presents with Pain and paraesthesia (44%).

CONCLUSION

- Compartment syndrome is more often a clinical diagnosis.
- It is difficult to measure the compartment pressures in patients admitted in large volume centers.
- Hence these should be high index of suspicious for compartment syndrome.
- If compartment syndrome is suspected, do liberal and adequate fasciotomy.
- A simple fasciotomy can save limb and prevent morbidity in the patient.

BIBLIOGRAPHY

1) Claes T, Van der Beek D, Claes S, Verfaillie S, Bataillie F. Chronic exertional compartment syndrome of the forearm in motocross racers. Presented at: The European Sports Medicine Congress; Hasselt, Belgium; May 14-16, 2003.

2) Goubier JN, Saillant G. Chronic compartment syndrome of the forearm in competitive motor cyclists: a report of two cases. *Br J Sports Med*. 2003;37(5):452-3; discussion 453-4.

3) Piasecki DP, Meyer D, Bach BR Jr. Exertional compartment syndrome of the forearm in an elite flatwater sprint kayaker. *Am J Sports Med*. Nov 2008;36(11):2222-5.

4) Qvarfordt P, Christenson JT, Eklof B, et al. Intramuscular pressure, muscle blood flow, and skeletal muscle metabolism in chronic anterior tibial compartment syndrome. *Clin Orthop*. Oct 1983;(179):284-90.

5) Bleicher RJ, Sherman HF, Latenser BA. Bilateral gluteal compartment syndrome. *J Trauma*. Jan 1997;42(1):118-22.

6) Tekwani K, Sikka R. High-risk chief complaints III: abdomen and extremities. *Emerg Med Clin North Am*. Nov 2009;27(4):747-65, x.

7) von Volkmann R. Veilletzungen und Krankenheiten der Berwegungsorgane. In: von Pithe F, Billroth T. Stuttgart, Verlag von Ferdinand Enke, eds. *Handbuch der Allgemeinen und Speziellen Chirurgs*. Zweiter Band, Zweiter Abteilung, Abschmitt V, Ersted haft: 1882:234-920.

8) Jepson PN. Ischaemic contracture: experimental study. *Ann Surg*. 1926;84:785-95.

9) Owen CA, Mubarak SJ, Hargens AR, Rutherford L, Garetto LP, Akeson WH. Intramuscular pressures with limb compression clarification of the pathogenesis of the drug-induced muscle-compartment syndrome. *N Engl J Med*. May 24 1979;300(21):1169-72.

10) Matsen FA 3rd. Compartmental syndrome. An unified concept. *Clin Orthop Relat Res*. Nov-Dec 1975;8-14.

11) Amendala A, Rorabeck CH. Chronic exertional compartment syndrome. In: Welsh RP, Shepard RJ, eds.*Current Therapy in Sports Medicine*. 1985. Toronto, Canada: BC Decker; 250-2.

12) Blackman P, Bradshaw C, Crossley K. Chronic exertional compartment syndrome in the lower leg. A comparison of treatment options and outcome. International Conference of Science and Medicine in Sports, Brisbane, Australia. 1994;56-7.

13) Blackman PG. A review of chronic exertional compartment syndrome in the lower leg. *Med Sci Sports Exerc*. Mar 2000;32(3 Suppl):S4-10.

14) Eisele SA, Sammarco GJ. Chronic exertional compartment syndrome. *Instr Course Lect*. 1993;42:213-7.

15) Howard JL, Mohtadi NG, Wiley JP. Evaluation of outcomes in patients following surgical treatment of chronic exertional compartment syndrome in the leg. *Clin J Sport Med*. Jul 2000;10(3):176-84.

16) Liem NR, Bourque PR, Michaud C. Acute exertional compartment syndrome in the setting of anabolic steroids: an unusual cause of bilateral footdrop. *Muscle Nerve*. Jul 2005;32(1):113-7.

17) Mouhsine E, Garofalo R, Moretti B, et al. Two minimal incision fasciotomy for chronic exertional compartment

syndrome of the lower leg. *Knee Surg Sports Traumatol Arthrosc*. Feb 2006;14(2):193-7.

18) Schepsis AA, Martini D, Corbett M. Surgical management of exertional compartment syndrome of the lower leg. Long-term followup. *Am J Sports Med*. Nov-Dec 1993;21(6):811-7; discussion 817.

19) Clayton JM, Hayes AC, Barnes RW. Tissue pressure and perfusion in the compartment syndrome. *J Surg Res*. Apr 1977;22(4):333-9.

20) Shrier I, Magder S. Pressure-flow relationships in in vitro model of compartment syndrome. *J Appl Physiol*. Jul 1995;79(1):214-21.

21) Beraldo S, Dodds SR. Lower limb acute compartment syndrome after colorectal surgery in prolonged lithotomy position. *Dis Colon Rectum*. Nov 2006;49(11):1772-80.

22) Walker JL, Smith GH, Gaston MS, Robinson CM. Spontaneous compartment syndrome in association with simvastatin-induced myositis. *Emerg Med J*. May 2008;25(5):305-6.

23) Detmer DE, Sharpe K, Sufit RL, et al. Chronic compartment syndrome: diagnosis, management, and outcomes. *Am J Sports Med*. May-Jun 1985;13(3):162-70.

24) Mubarak SJ, Hargens AR. Acute compartment syndromes. *Surg Clin North Am*. Jun 1983;63(3):539-65.

25) King TW, Lerman OZ, Carter JJ, Warren SM. Exertional compartment syndrome of the thigh: a rare diagnosis and literature review. *J Emerg Med*. Aug 2010;39(2):e93-9.

26) Naidu KS, Chin T, Harris C, Talbot S. Bilateral peroneal compartment syndrome after horse riding. *Am J Emerg Med*. Sep 2009;27(7):901.e3-5.

27) Malic CC, Hernon C, Austin O, Phipps A. Scalded and swollen-beware the underlying compartment syndrome. *Burns*. Jun 2006;32(4):504-6.

28) Crick KA, Crick JC, Pulley MT. Hemorrhagic upper extremity complications from tissue plasminogen activator. *J Surg Orthop Adv*. Spring 2007;16(1):27-30.

29) Wang KL, Li SY, Chuang CL, Chen TW, Chen JY. Subfascial hematoma progressed to arm compartment syndrome due to a

nontransposed brachiobasilic fistula. *Am J Kidney Dis*. Dec 2006;48(6):990-2.

30) Rafiq I, Anderson DJ. Acute rhabdomyolysis following acute compartment syndrome of upper arm. *J Coll Physicians Surg Pak*. Nov 2006;16(11):734-5.

31) Swaringen JC, Seiler JG 3rd, Bruce RW Jr. Influenza A induced rhabdomyolysis resulting in extensive compartment syndrome. *Clin Orthop Relat Res*. Jun 2000;243-9.

32) Wirth JJ, Sheka KP, Gheewala A, Rowe NM. Acquired immune deficiency syndrome and systemic lupus erythematosis: potential causes of surgical emergencies of the hand. *Ann Plast Surg*. Jul 2008;61(1):35-9.

33) Rahm M, Probe R. Extensive deep venous thrombosis resulting in compartment syndrome of the thigh and leg. A case report. *J Bone Joint Surg Am*. Dec 1994;76(12):1854-7.

34) Aprahamian C, Gessert G, Bandyk DF, Sell L, Stiehl J, Olson DW. MAST-associated compartment syndrome (MACS): a review. *J Trauma*. May 1989;29(5):549-55.

35) Ashton H. Effect of inflatable plastic splints on blood flow. *Br Med J*. Dec 10 1966;2(5527):1427-30.

36) Verdolin MH, Toth AS, Schroeder R. Bilateral lower extremity compartment syndromes following prolonged surgery in the low lithotomy position with serial compression stockings. *Anesthesiology*. Apr 2000;92(4):1189-91.

37) Dailiana HZ, Kotsaki D, Varitimidis S, et al. Injection injuries: seemingly minor injuries with major consequences. *Hippokratia*. Jan 2008;12(1):33-6.

38) McQueen MM, Court-Brown CM. Compartment monitoring in tibial fractures. The pressure threshold for decompression. *J Bone Joint Surg Br*. Jan 1996;78(1):99-104.

39) McQueen MM, Duckworth AD, Aitken SA, Court-Brown CM. The estimated sensitivity and specificity of compartment pressure monitoring for acute compartment syndrome. *J Bone Joint Surg Am*. Apr 17 2013;95(8):673-7.

40) DeLee JC, Stiehl JB. Open tibia fracture with compartment syndrome. *Clin Orthop Relat Res*. Oct 1981;175-84.

41) Feliciano DV, Cruse PA, Spjut-Patrinely V, Burch JM, Mattox KL. Fasciotomy after trauma to the extremities. *Am J Surg*. Dec 1988;156(6):533-6.

42) Rorabeck CH, Macnab I. The pathophysiology of the anterior tibial compartmental syndrome. *Clin Orthop Relat Res*. Nov-Dec 1975;52-7.

43) Matsen FA 3rd, Winquist RA, Krugmire RB Jr. Diagnosis and management of compartmental syndromes.*J Bone Joint Surg Am*. Mar 1980;62(2):286-91.

44) Sheridan GW, Matsen FA 3rd. Fasciotomy in the treatment of the acute compartment syndrome. *J Bone Joint Surg Am*. Jan 1976;58(1):112-5.

45) Rockwood CA Jr, Green DP, Bucholz RW, Heckman JD, eds. *Rockwood and Green's Fractures in Adults*. 4th ed. Philadelphia, Pa: Lippincott-Raven; 1996.

46) Matsen FA 3rd, Winquist RA, Krugmire RB Jr. Diagnosis and management of compartmental syndromes.*J Bone Joint Surg Am*. Mar 1980;62(2):286-91.

47) Cincinnati Children's Hospital Medical Center. *Evidence-based care guideline for femoral shaft fractures*. Cincinnati (OH): Cincinnati Children's Hospital Medical Center; Dec 2006:.

48) Reach JS Jr, Amrami KK, Felmlee JP, et al. The compartments of the foot: a 3-tesla magnetic resonance imaging study with clinical correlates for needle pressure testing. *Foot Ankle Int*. May 2007;28(5):584-94.

49) Yu JS, Habib P. MR imaging of urgent inflammatory and infectious conditions affecting the soft tissues of the musculoskeletal system. *Emerg Radiol*. Jan 9 2009;

50) Jones WG 2nd, Perry MO, Bush HL Jr. Changes in tibial venous blood flow in the evolving compartment syndrome. *Arch Surg*. Jul 1989;124(7):801-4.

51) Mubarak SJ, Hargens AR, Owen CA, Garetto LP, Akeson WH. The wick catheter technique for measurement of intramuscular pressure. A new research and clinical tool. *J Bone Joint Surg Am*. Oct 1976;58(7):1016-20.

52) Styf J, Wiger P. Abnormally increased intramuscular pressure in human legs: comparison of two experimental models. *J Trauma*. Jul 1998;45(1):133-9.

53) Matsen FA 3rd, Wyss CR, Krugmire RB Jr, Simmons CW, King RV. The effects of limb elevation and dependency on local arteriovenous gradients in normal human limbs with particular reference to limbs with increased tissue pressure. *Clin Orthop Relat Res*. Jul-Aug 1980;187-95.

54) Garfin SR, Mubarak SJ, Evans KL, Hargens AR, Akeson WH. Quantification of intracompartmental pressure and volume under plaster casts. *J Bone Joint Surg Am*. Mar 1981;63(3):449-53.

55) Wallensten R, Karlsson J. Histochemical and metabolic changes in lower leg muscles in exercise- induced pain. *Int J Sports Med*. Aug 1984;5(4):202-8.

56) Better OS, Zinman C, Reis DN, et al. Hypertonic mannitol ameliorates intracompartmental tamponade in model compartment syndrome in the dog. *Nephron*. 1991;58(3):344-6.

57) Shah DM, Bock DE, Darling RC 3rd, et al. Beneficial effects of hypertonic mannitol in acute ischemia--reperfusion injuries in humans. *Cardiovasc Surg*. Feb 1996;4(1):97-100.

58) Daniels M, Reichman J, Brezis M. Mannitol treatment for acute compartment syndrome. *Nephron*. Aug 1998;79(4):492-3.

59) Pollak AN. Use of negative pressure wound therapy with reticulated open cell foam for lower extremity trauma. *J Orthop Trauma*. Nov-Dec 2008;22(10 Suppl):S142-5.

60) Brey JM, Castro MD. Salvage of compartment syndrome of the leg and foot. *Foot Ankle Clin*. Dec 2008;13(4):767-72.

61) McQueen MM, Court-Brown CM. Compartment monitoring in tibial fractures. The pressure threshold for decompression. *J Bone Joint Surg Br*. Jan 1996;78(1):99-104.

62) Bible JE, McClure DJ, Mir HR. Analysis of One vs. Two-Incision Fasciotomy for Tibial Fractures with Acute Compartment Syndrome. *J Orthop Trauma*. Apr 19 2013;

63) Whitesides TE, Haney TC, Morimoto K, Harada H. Tissue pressure measurements as a determinant for the need of fasciotomy. *Clin Orthop Relat Res*. Nov-Dec 1975;43-51.

64) Whitesides TE Jr, Haney TC, Harada H, Holmes HE, Morimoto K. A simple method for tissue pressure determination. *Arch Surg*. Nov 1975;110(11):1311-3.

65) Arato E, Kurthy M, Sinay L, et al. Pathology and diagnostic options of lower limb compartment syndrome.*Clin Hemorheol Microcirc*. 2009;41(1):18.

66) Nillius A, Rööser B. [Acute compartment syndrome in knee arthroscopy]. *Lakartidningen*. Feb 16 1983;80(7):590.

67) Peek RD, Haynes DW. Compartment syndrome as a complication of arthroscopy. A case report and a study of interstitial pressures. *Am J Sports Med*. Nov-Dec 1984;12(6):464-8.

68) Fruensgaard S, Holm A. Compartment syndrome complicating arthroscopic surgery: brief report. *J Bone Joint Surg Br*. Jan 1988;70(1):146-7.

69) Kaper BP, Carr CF, Shirreffs TG. Compartment syndrome after arthroscopic surgery of knee. A report of two cases managed nonoperatively. *Am J Sports Med*. Jan-Feb 1997;25(1):123-5.

70) Undersea and Hyperbaric Medical Society. June 2003. Indications for hyperbaric oxygen therapy.

71) Wattel F, Mathieu D, Nevière R, Bocquillon N. Acute peripheral ischaemia and compartment syndromes: a role for hyperbaric oxygenation. *Anaesthesia*. May 1998;53 Suppl 2:63-5.

72) Mar GJ, Barrington MJ, McGuirk BR. Acute compartment syndrome of the lower limb and the effect of postoperative analgesia on diagnosis. *Br J Anaesth*. Jan 2009;102(1):3-11.

73) Bywaters EG, Beall D. Crush injuries with impairment of renal function. 1941. *J Am Soc Nephrol*. Feb 1998;9(2):322-32.

74) Hutchinson MR, Ireland ML. Common compartment syndromes in athletes. Treatment and rehabilitation.*Sports Med*. Mar 1994;17(3):200-8.

75) Boody AR Wongworawat MD: Accuracy in the measurement of compartment pressures: a comparison of three commonly used devices , J Bone Joint Surg 87A:2415, 2005.

76) Croutzet P, Chassat R Masmejean EH: Mini-invasive Surgery for chronic external compartment syndrome of the forearm : a new technique, Tech Hand Up Extrem Surg 13:137,2009.

77) Elliot KG, Johnstone AJ: Diagnosing Acute compartment syndrome, J Bone Joint Surg 85B:625, 2003.

78) Grottkau BE, Epps HR, Di Scala C: compartment syndrome in children and adolescents, J Pediatr Surg 40:678 , 2005

79) Hwang RW , de witte PB, Ring D: compartment syndrome associated with distal radial fracture and ipsilateral elbow injury, J Bone Joint Surg 91A:642, 2009.

80) Kalyani BS , Fisher BE,Roberts CS, Giannoudis PV: compartment syndrome of the forearm : a systemic review, J Hand Surg 36A:535, 2011.

81) Kumar PR , Jenkins JPR , Hodgson SP: Bilateral chronic exertional compartment syndrome of the dorsal part of the

forearm: the role of magnetic resonance imaging in diagnosis: a case report, J bone Joint Surg 85 A: 1557, 2003.

82) Lipschitz AH, Lifchez SD: Measurement of compartment pressures in the hand and forearm, J Hand surg 35A: 1893, 2010.

83) McQueen MM, Gaston P, Court-Brown CM: Acute compartment syndrome: who is at risk? J Bone Joint Surg 82B:200, 2000.

84) Ronel DN, Mtui E , Nolan WB 3rd : forearm compartment syndrome: anatomical analysis of surgical approachs to the deep space, plast reconstr surg 114:697, 2004.

85) Van den Brand JG, Nelson T, Verleisdonk EG, van der Werken C: the diagnostic value of intracompartmental pressure measurement, magnetic resonance imaging, and near infrared spectroscopy in chronic exertional compartment syndrome: a prospective study in 50 patients, Am J Sports Med 33:699, 2005.

86) Yuan PS, Pring ME, Gaynor TP, et al: compartment syndrome following intramedullary fixation of pediatric forearm fractures, J Pediatr Orthop 24:370, 2004.

PROFORMA

PATIENT DETAILS

ONE ADMISSION

Name: Age: Sex: IP No:

Duration of Symptoms:

1) H/o. Swelling of Limbs
   a. Duration x
   b. Time since onset of injury & swelling (< 2 hours/ > 2 hours)
   c. Increasing
2) H/o. Pain in both leg
   a. Duration x
   b. Time since onset of injury & pain (<2 hours / > 2 hours)
3) H/o. any altered sensation – Yes/ No
4) H/o. Claudication – Yes/ No
5) Mode of Injury
6) Previous H/o. any surgery
7) Previous H/o. any IV drug usage
8) Previous H/o. any drug intake

CLINICAL EXAMINATION

Pulse :

BP :

1) Attitude of the limb
2) Any deformity
3) Any external wound

4) Swelling of Limb

5) Local temperature

6) Any discoloration

7) Peripheral pulses

8) Capillary refilling time

9) Pain during active movement or passive movement of limb

10) Sensory Examination

INVESTIGATIONS

Hemogram

Renal Function Test

BT/CT/PT/INR/ Aptt

Urine Analysis

Arterial Doppler

Venous Doppler

S. No	Name	Age	Sex	IP No	Limb Involvement	Site	Etiology	Pain	Altered Sensation	Pain on Passive Stretching	Sensory Examination	Motor Examination	X-Ray	Arterial Doppler	Venous Doppler
1	Kannaiyan	39	male	98938	Left LL	Thigh & leg	Varicose vein surgery	Yes	Yes	No	abnormal	Normal	NBI	Normal	Absent flow in fem/pop/ant & pst tibial.V
2	Ravikumar	48	male	96324	Right LL	Thigh & leg	Varicose vein surgery	Yes	Yes	Yes	abnormal	Normal	NBI	Monophasic flow Rt. Ant & Post Tibial A.	Absent flow in fem/pop/ant &pst tibial.V
3	Saradhammal	70	female	60369	Right LL	Foot	Infection	Yes	Yes	No	abnormal	Normal	NBI	Normal	Normal
4	Padmavathy	50	female	72059	Right LL	Leg & Foot	Snake bite	No	Yes	No	decreased	Normal	NBI	Normal	Normal
5	Susheela	48	female	65072	Right LL	Thigh & leg	Snake bite	No	No	Yes	normal	Normal	NBI	Normal	Normal
6	Krishnan	51	male	69963	Right LL	Thigh & leg	Snake bite	Yes	Yes	No	abnormal	Normal	NBI	Normal	Normal
7	Ahmath Jeena	43	male	67330	Right LL	Leg & Foot	Snake bite	Yes	Yes	Yes	abnormal	Paresis +	NBI	Monophasic flow Rt. Ant & Post Tibial A.	Normal
8	Nallasamy	61	male	65077	Right LL	Foot	Infection	No	No	Yes	normal	Normal	NBI	Normal	Normal
9	Murugesan	75	male	62489	Left LL	Leg & Foot	Snake bite	No	No	Yes	normal	Normal	NBI	Normal	Normal
10	Shantha	30	female	74202	Left LL	Thigh & leg	Burns	Yes	Yes	Yes	normal	Normal	NBI	Normal	Normal
11	Anjalai	55	female	81411	Right LL	Leg & Foot	Burns	Yes	Yes	Yes	decreased	Normal	NBI	Monophasic flow Rt. Ant & Post Tibial A.	Normal
12	Murali	52	male	88503	right UL	Forearm & hand	Electrocution	No	No	Yes	normal	Normal	NBI	Normal	Normal
13	Egavalli	55	female	93833	left UL	Forearm & hand	Burns	Yes	No	Yes	normal	Normal	NBI	Normal	Normal
14	Elumalai	48	male	83849	left UL	Forearm & hand	Drug abuse	Yes	Yes	Yes	decreased	Normal	NBI	Normal	Normal
15	Sadhasivam	30	male	86222	right UL	Arm	Snake bite	Yes	Yes	No	decreased	Normal	NBI	Normal	Normal
16	Rajeswaran	35	male	86363	left UL	Forearm & hand	Burns	Yes	Yes	No	decreased	Normal	NBI	Normal	Normal
17	Kamatchi	70	female	76404	left UL	Forearm & hand	Drug Extravasation	Yes	Yes	No	decreased	Normal	NBI	Normal	Normal
18	Subramani	45	male	79113	left UL	Forearm & hand	Drug Extravasation	Yes	Yes	No	decreased	Normal	NBI	Normal	Normal
19	Murugadoss	82	male	106070	Right LL	Leg & Foot	Polytrauma	Yes	Yes	No	decreased	Normal	# lower 1/3 BB	Normal	Normal
20	valliyammal	37	female	76406	right UL	Arm	Snake bite	Yes	Yes	No	decreased	Normal	NBI	Normal	Normal
21	Mohd Saha	27	male	44610	Left LL	thigh	Polytrauma	Yes	No	Yes	normal	Normal	# shaft of femur	Normal	Normal
22	Raja narayanan	39	male	54313	Right LL	Leg & Foot	Arterial ischemia	Yes	No	Yes	normal	Normal	NBI	absent flow in AT,PT,DPA	Normal
23	Venkatachalam	40	male	47105	Right LL	Thigh & leg	Arterial ischemia	Yes	No	Yes	normal	Normal	NBI	monophasic flow in femoral/ popliteal	Normal
24	amirthagowri	58	female	44333	left LL	Thigh & leg	Arterial ischemia	Yes	No	Yes	normal	Normal	NBI	monophasicflow in fem/pop/AT/PT	Normal
25	Charles	53	male	37661	Right LL	Thigh & leg	Arterial ischemia	Yes	Yes	Yes	abnormal	Normal	NBI	monophasic flow in fem/pop/AT/PT	Normal
26	Muthammal	40	female	45675	Right LL	thigh	Polytrauma	Yes	No	No	normal	Normal	# shaft of femur	Normal	Normal

S. No	Name	Age	Sex	IP No	Limb Involvement	Site	Etiology	Pain	Altered Sensation	Pain on Passive Stretching	Sensory Examination	Motor Examination	X-Ray	Arterial Doppler	Venous Doppler
27	Logesh	25	male	44354	Left LL	Leg & Foot	Polytrauma	Yes	Yes	No	abnormal	Normal	# both bone	monophasic flow AT/PT	Normal
28	Zareena begum	60	female	35289	Right LL	Leg & Foot	Polytrauma	Yes	Yes	No	abnormal	Normal	# both bone lower 1/3	monophasic flow AT/PT	Normal
29	Janitha Bee	85	female	33124	Left LL	Leg & Foot	Polytrauma	Yes	Yes	No	abnormal	Normal	# both bone	Normal	Normal
30	David	45	male	39694	Left LL	thigh	Polytrauma	Yes	Yes	No	abnormal	Normal	# shaft of femur	Normal	Normal
31	Ashik meeran	19	male	37567	Left LL	leg	Polytrauma	Yes	Yes	Yes	abnormal	Normal	# both bone lower 1/3	monophasic flow AT/PT	Normal
32	Velu	43	male	103313	Left LL	leg	Polytrauma	Yes	Yes	Yes	abnormal	Normal	# both bone upper 1/3	monophasic flow AT/PT	Normal
33	Babu	56	male	96324	Left LL	leg	Polytrauma	Yes	Yes	Yes	abnormal	decreased	# tibia	monophasic flow AT/PT	Normal
34	Selvam	58	male	100834	Left LL	leg	DVT	Yes	Yes	No	abnormal	Normal	NBI	Normal	thrombus in AT/PT
35	Kala	28	female	68258	Right LL	Thigh & leg	DVT	No	No	Yes	normal	Normal	NBI	Normal	thrombus in Rt. Sup&deep femoral
36	Maheswari	48	female	60522	Right LL	Thigh & leg	DVT	No	Yes	No	decreased	Normal	NBI	Normal	thrombus in Rt. Sup&deep femoral
37	Basha	52	male	51943	Right LL	Leg & Foot	Arterial ischemia	Yes	No	Yes	normal	Normal	NBI	absent flow in AT,PT,DPA	Normal
38	Lakshmi	78	female	39684	Right LL	Leg & Foot	Arterial ischemia	Yes	Yes	Yes	abnormal	Normal	NBI	monophasic flow AT/PT/DPA	Normal
39	Munusamy	82	male	100868	Left LL	leg	Infection	Yes	Yes	No	decreased	Normal	NBI	Normal	Normal
40	Pachaiammal	46	female	102384	Left LL	leg	Infection	Yes	Yes	No	decreased	Normal	NBI	Normal	Normal
41	Fathima	40	female	118388	left LL	leg	Infection	Yes	No	Yes	normal	Normal	NBI	Normal	Normal
42	Subramani	75	male	11643	Right LL	leg	Polytrauma	Yes	Yes	No	decreased	Normal	# both bone upper 1/3	Normal	Normal
43	Banu	80	female	60840	Right LL	leg	Polytrauma	Yes	No	Yes	normal	Normal	# both bone leg	Normal	Normal
44	Nethaji	67	male	111168	Right LL	leg	Polytrauma	Yes	Yes	No	decreased	Normal	# both bone upper 1/3	Normal	Normal
45	Deviammal	75	female	78578	Right LL	leg	Polytrauma	Yes	No	Yes	normal	Normal	# tibia	Normal	Normal
46	Amutha	20	female	33129	Left LL	leg	Polytrauma	Yes	Yes	No	decreased	Normal	# both bone upper 1/3	Normal	Normal
47	Ragini	55	female	37509	Right LL	leg	Polytrauma	Yes	Yes	Yes	decreased	Normal	# tibia	Monophasic flow Rt. Ant & Post Tibial A.	Normal
48	Murugan	30	male	44513	Right LL	thigh	Polytrauma	Yes	Yes	No	decreased	Normal	# shaft of femur	Normal	Normal
49	Pandiyan	26	male	91408	both LL	Leg & Foot	Burns	Yes	Yes	Yes	decreased	Normal	NBI	Normal	Normal

S. No	Name	Age	Sex	IP No	Limb Involvement	Site	Etiology	Pain	Altered Sensation	Pain on Passive Stretching	Sensory Examination	Motor Examination	X-Ray	Arterial Doppler	Venous Doppler
50	Muniammal	50	female	120759	Right LL	leg	Polytrauma	Yes	No	Yes	normal	Normal	# tibia upper 1/3	Normal	Normal

INTRODUCTION

Compartment Syndrome develops when pressure of tissue in a closed fascio osseus compartment more than the perfusion pressure. It will lead to reduction in blood supply to muscles and nerve. It is mainly due to trauma, the most common etiology will be fracture.

Acute Compartment Syndrome is a cyclical event when the pressure within the tissue is more than the pressure in the blood vessel. It consequently leads to reduction in blood flow. It leads to poor oxygenation of tissues and there will be no washing out of products of metabolites. It prominently affects the nerve first and leads onto sensory disturbances.

Late consequence of this include arterial pulses will be absent, numbness particularly fine touch and two point discrimination, paresis of the involved muscle. All these are the consequence of reduced blood flow. If this is not treated within a particular interval of time, necrosis of tissue within the